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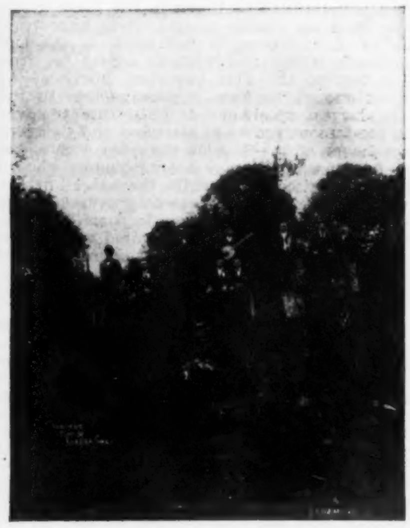
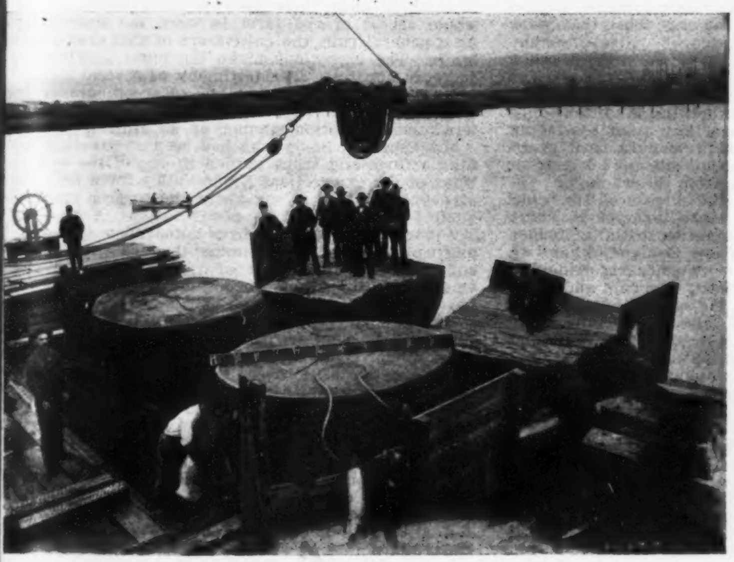
REDWOOD TREE 21 FEET IN DIAMETER.

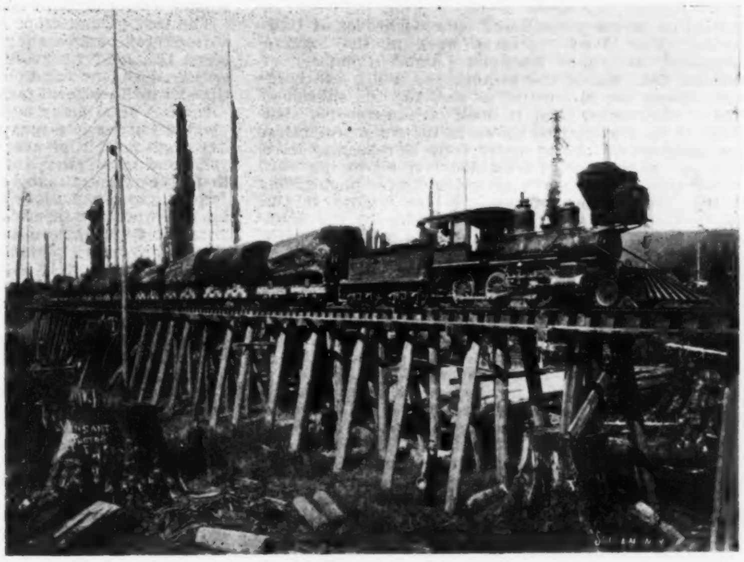
THE BUTT OF A REDWOOD 16½ FEET IN DIAMETER.



STUMP 25 FEET ACROSS THE TOP.

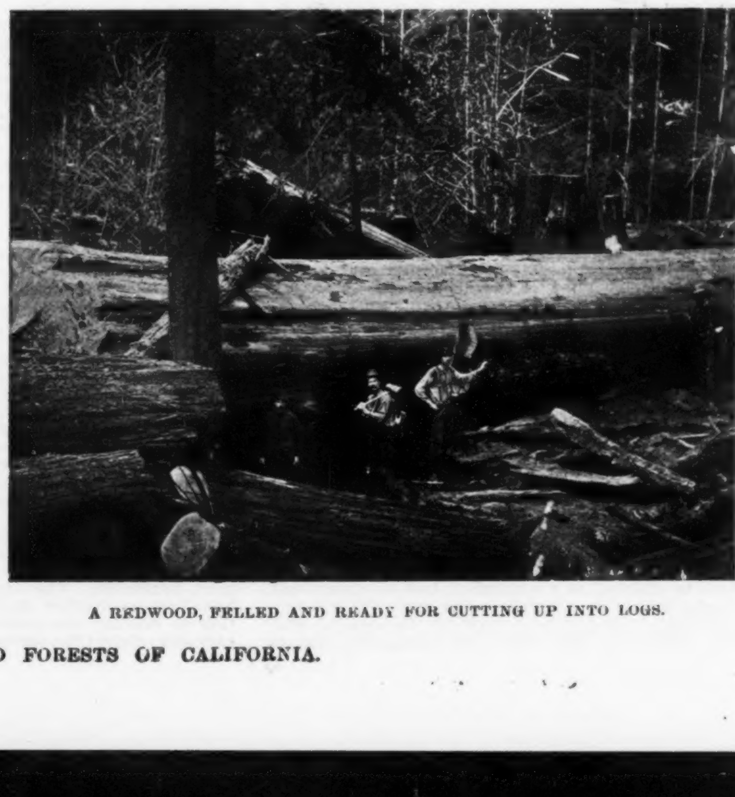


SHIPPING LOGS BY WATER FROM EUREKA, CALIFORNIA.



A TRAINLOAD OF LOGS.

REDWOOD SLAB, 16 FEET BY 12 FEET 9 INCHES, 5 INCHES THICK.



A REDWOOD, FELLED AND READY FOR CUTTING UP INTO LOGS.

LOGGING IN THE REDWOOD FORESTS OF CALIFORNIA.

LOGGING IN THE REDWOOD FORESTS OF CALIFORNIA.

AMONG the many natural wonders of western America are the forests of giant trees which cover the lower slopes of the Rocky Mountains, the Sierra Nevada and the Cascade Mountains, and the coast ranges which reach from the Columbia River down through western Oregon and California. To a traveler from the Eastern States there is no feature of the country lying between the Pacific Ocean and the Rocky Mountain range which creates so strong an impression as the size and character of the forest timber. The oak, the maple, the elm, and a dozen other varieties which are familiar to residents in the country east of the Alleghenies cease to form a feature of the landscape; and as the train climbs the eastern slopes of "the great divide," the traveler catches his first glimpse of the giant trees of the West, the rounded and gentle outline of the densely massed foliage of Eastern trees being replaced by the tall and sentinel-like forms of the redwood of California and the pine and fir of Oregon and Washington. The finest specimens are to be found in the large groves, where the trees are closely massed, their huge trunks, from 10 to 25 and even 30 feet thick at the butt, rising perfectly plumb and without a limb for from 100 to 150 feet to the first branches, many of which are thick enough to form a massive tree in themselves. The largest specimens of California trees are found in the famous groves at Mariposa and Calaveras, where specimens of the Sequoia Gigantea with a diameter of 30 feet at the butt were not uncommon when the grove was first discovered, while the height of these truly wonderful trees was frequently over 300 feet, and is even estimated to have been in some cases as great as 400 feet. The two most celebrated varieties of the big trees of the West are the Douglas fir, found in the immense forests which abound in Washington and Oregon, and the redwood trees of California. The Douglas fir is the Western counterpart of the Southern pine. Like it, it is admirably suited, by virtue of its great bending strength, for bridge and roof work, and all classes of framed structures, and the Douglas fir of Oregon is likely ever to remain the favorite wood for use in the racing spars of yachts of the larger class. The redwood trees of California, on the other hand, not only furnish a timber which affords wonderful resistance to deterioration when exposed to the weather, but is possessed of an exceedingly fine and beautiful grain and color, which makes it a choice wood for the interior decoration of houses. It is very largely used for this purpose in the West, and has become increasingly popular of late years in the East.

The accompanying group of photographs gives a very graphic impression of the logging industry, as carried on in the magnificent redwood groves of California. The views represent work in the logging camps of the Vance Redwood Lumber Company of Eureka, Cal. All of the photographs which are herewith shown are instructive as showing the enormous size of the timber, and it must be remembered that many of the log sections shown in the cut representing the shipment of logs by water from Eureka may have been cut a distance of over 100 feet above the butt of the tree. Perhaps the most impressive photograph is that showing one of the latest cuts taken in the Vance Logging Camp. A general idea of the enormous amount of lumber contained in a tree, measuring like this 16½ feet at the butt, may be gathered from the following dimensions:

The total length	300	feet.
Length from butt to first limb	150	feet.
Diameter at butt	16½	feet.
Average diameter of logs	12	feet.
Full contents of logs in board measure	166,125	feet.
Weight of logs estimated at 4½ pounds per foot board measure	273	tons.
Bark on the tree, 6 inches in thickness.		

The number of days from the time the choppers commenced until the tree was made up into logs, ready for transportation, was four and three-quarters. As the largest logs were split in the woods before transportation, it took nine logging cars to haul the logs to the mill.

After communication with a belt of timber has been established, these noble trees, the lives of many of which are measured by the thousand years, begin to fall beneath the ax and crosscut saw. One cannot but feel on sentimental grounds the deepest regret that these stately and monumental specimens of tree life should be so ruthlessly swept away, and the pity of it all is only partly mitigated when we remember that the timber thus cut up is turned to a thousand valuable commercial uses. In felling the trees, a cut about half way through is made on the side of the tree toward which it is to fall, and the tree is then sawn through from the opposite side. This is in the case of trees of only moderate dimensions; in the cases of the larger trees the crosscut saw is used more freely. The falling of a 250-foot tree is a thrilling sight, never to be forgotten. The first warning is given by the crackling of the fibers as the saw cuts away the small remaining wood that keeps the tree up. The top of the tree is then seen to move slowly across the clouds as the giant bends slowly to its fall. With an angry "swish" and increasing momentum it describes a giant quarter-circle to the ground, the blow of its 200 to 300 tons of weight making the earth tremble as from an earthquake shock. The logs, as will be seen in the illustrations, are of unusual size, the majority of them running from 5 to 16 feet in diameter. For convenience of handling, all of the logs over a certain diameter are blasted into sections with powder before they are shipped down to the mills. The logs are hauled to a logging railroad by means of a portable engine which, for convenience of transportation, is bolted to a sled. When it is desired to move this sled, the wire cable is run through a pulley which is attached to a convenient tree or stump, and brought back and fastened to the sled. By winding on the cable the engine is drawn to the desired position. When the logs are to be moved, the sled is chained to a tree, and the hauling is accomplished by running a steel rope through as many steel pulleys as may be required. The logs are hauled to the railroad over chutes formed of two parallel lines of logs or poles laid on the ground and freely greased with tallow. They are taken down by the railroad to the sawmill and worked up into merchantable lumber.

WHAT ARE SOME OF THE BEST PAYING CROPS?

By H. M. SESSIONS.

THIS question will admit of a great variety of answers. The gardener, producing vegetables for the market, would give one answer; the horticulturist, cultivating the smaller fruits for a near market, would give another, and the agriculturist, farming on a larger scale, distant from market, still another.

We have taken notes for this paper, and propose to enumerate some of the crops which the members of the Harvest Club in the section of the Connecticut River Valley near Springfield, Mass., can raise with success, and apply the same to the farmers of this and other sections of the country. What is the best paying crop? It is generally considered the one that brings the most money at the present time. But if, in a term of years, it should be found to exhaust the soil, and reduce the succeeding crops, it may not be as profitable as at first appears. And then again, in the same locality, the crop that one man can raise successfully, and at an evident profit, his neighbor may utterly fail to cultivate with success. The abilities of men vary among farmers, as well as among mechanics. A wheelwright might not be able to construct a watch, nor a house-carpenter to build an engine. So the farmer who can raise corn and wheat may fail in raising vegetables; and a man in the dairy business may not succeed in raising fruit. This question admits of as great a variety of answers as there are farms or farmers.

In deciding this question, the farmer must consider his locality, in regard to market; the condition of his family, in regard to health and numbers; the extent of his farm, and the character of the soil. A farmer on a 10-acre farm near a city might not engage in stock raising with as much profit as in gardening. Most of the land of a 200-acre farm, distant from market, might lie idle and run to waste but for the stock that is kept to graze on its surface at a profit. Our mountain farms will produce apples of longer keeping qualities, and with more profit, than the sandy plains or alluvial bottoms of the Connecticut Valley. In 1874, when there was the largest crop of apples ever known in New England, and many thought they would scarcely pay for the labor of gathering, our receipts amounted to over $1,000 for the crop of that year from a young orchard on a mountain farm.

The best paying crops are not only those that yield a fair profit above the expenses of cultivating, but leave the land in good condition to produce other crops. Corn, cows and clover rank high at the present time with the general farmer.

Instead of so many acres in mowing land, that only yield a ton, or less, per acre of hay annually, let us have one-quarter of the mowing land in corn every year, and in a few years we shall cut more hay from the three-quarters than before from the whole.

Corn, Cows and Clover are the three crops to bring up our worn-out farms, and make them pay. There is no doubt that corn in connection with its fodder can be grown with profit in New England, where we used to live, as well as in the West, as is evidenced in many late reports; also wheat, rye, oats and buckwheat to a limited extent.

The spring wheat we last raised on two separate lots yielded on one lot thirty bushels per acre, and on the other thirty-six bushels per acre; and the corn crop making from fifty to one hundred bushels per acre—as there is no trouble in doing on our best land, when well handled.

Cows, whether kept for milk or butter, making veal, or raising stock, are profitable, not only for the income received, but in keeping up and increasing the fertility of the farm. And as for clover, there is no better crop to feed the land, or feed the cows, and make each produce to their fullest extent. Early cut clover, well cured, and fed once a day, will produce more milk than all hay.

An eminent agriculturist, Lewis Harris, of New York State, has said that "the best feed for milch cows is grass—the next best, dried grass, whether it it rowen or early cut hay." All admit that rowen will make the most milk, and those who raise stock know that rowen is the best for calves or growing stock, and the most successful stall feeders of the Connecticut Valley feed three-fourths rowen. If, then, it will make the most milk, and growth and beef, what more does the farmer want? Cut the hay, then, when it is the most like grass, while it contains the most saccharine matter, and before the woody fiber is developed.

The grass crop of Massachusetts and New England is by far the largest crop raised. It used to be said that cotton was king, but corn now claims the kingdom of the West. But in Massachusetts grass is the most stately prince, and soon to reign supreme. Grass is the foundation of all our products, and the most important in every system of rotation. A few years in grass and the land is prepared to produce an abundant harvest of almost any crop that the farmer may choose to raise. It is a true saying—more grass—more stock; more stock—more manure; more manure—more crops of all kinds, and increased fertility of the soil, and profits on the balance sheet.

The great object aimed at in successful farming is to raise something to sell: some leading crop, the sale of which raises the income of the farm above the expenses. Not that we would recommend specialties in farming exclusively, for but few farms will admit of this. But with our mixed farming, which always secures, at least, a good living for the farmer and his family, we would recommend some one or two leading crops, from which the farmer will derive his income. The largest crops are not necessarily the most profitable. The extra expense for fertilizers, and their application, and the extra care and cultivation to produce the greatest crop, may increase the expenses above the extra amount of product from what it would be to raise an average crop. But an increase of the average yield, without increasing the expense of cultivation, will bring profit to the farmer.

Of all the stock kept on our farms, none make more satisfactory returns for the investment, and cost and care for keeping, than sheep; paying for themselves in lambs and wool every year, or 100 per cent on the investment, and leaving the worn-out pastures greatly improved in appearance and fertility by the sheep having ranged over them.

If a large portion of our worn-out lands were planted with forest trees, especially nut-bearing trees and sugar maples, and not neglect to plant out fruit orchards, the next generation would reap a rich harvest in the growing legacy which they would inherit.

In the fall of 1884 we planted pecans and black walnut nuts on the campus of Atlanta University, and in the fall of 1900 we saw these trees some twenty-five feet high, bearing nuts.

There is no one crop raised in the Connecticut Valley on which there has been so much money made and lost as on the tobacco crop. The profits have only been in money. The losses have been three-fold, not only in money, but in the loss of the general fertility of the farm, and in the habits and character of the man; and in many cases, all combined have bankrupted the estate. The crop is a very uncertain one, and the price still more uncertain. There is risk from beginning to end. Something is liable to injure the crop from the time the seed is put into the ground until it is harvested; yea more, until it is sold and the money received. It is liable to be injured by late frosts in the spring, and early frosts in the autumn; worms at the roots and worms on the leaves; winds and hail; rust and pole sweat; too much wet weather, and too much dry weather. It is the cause of great anxiety and constant care and watchfulness from beginning to end. The crop is food for neither man nor beast, and does not support life, but rather destroys it (especially lice and vermin). It is a deadly nicotine poison and is the cause of a large percentage of the deaths by heart failure, now so common in this country. It can be put to only one use, to minister to the filthy habits and perverted tastes of man. For this reason the market is easily overstocked, and prices are ruinous, because less than the cost of production. In passing through the section where tobacco is raised, one is struck with the appearance of the farms. All the fertilizers made on the farm, and all that money and credit can buy, are applied to a few acres near the barn, for the tobacco crop. The result is very heavy crops on the few acres, and very small crops, or none at all, on the rest of the farm. The grass crop is neglected; a small crop of corn is raised without manure, for there is none to spare. The tobacco must have it all. The brush and weeds increase on the line where once there used to be a fence, and the whole aspect of the farm is worn out and forlorn. As a general rule, the cultivators of this crop are the losers. The exceptions make the money. Where one succeeds, ten fail. The testimony of several members of this club, who have raised tobacco more or less for twenty years, has been that they have never bettered their condition, financially, by raising tobacco.

Mr. Seymour Bagg, who has been successfully running a farm and truck garden in one of the best sections of the Connecticut River Valley for a long term of years, has this to say about the tobacco crop. We quote his words:

"The tobacco crop has been doted upon, and petted, and consequently made famous through the Connecticut Valley as the savior of the farmer; and there was at one time some encouragement; but alas, and too soon, perhaps, a relapse came, and the grower to-day is financially worse off than before, and continues to ask what are some of the best paying crops?"

As we have based all crops on land well suited to raise one ton of tobacco per acre, we will place it there, 2,000 pounds per acre, at the average price of 10 cents per pound, we have to add to our bank account the sum of $200 per acre. Mr. Bagg further says:

"I am so far from being pleased with my success in raising tobacco, and the success of others of my immediate acquaintance, that I refrain from further comments."

A great saving of time and labor in planting gardens, and not being obliged to plant them every year, is to plant such varieties as have perennial roots, that will produce a succession of crops for several years without replanting, such as rhubarb or pie plant, asparagus and dandelions; also many for seasoning or relish, as sage, the mints, and others. The first two named will last a generation. Five years ago, in our own garden in the city of Columbus, Ohio, we planted some of the improved thick-leaved dandelion seed, in double rows, one foot apart, and the double rows, two feet apart, that yield three cuttings every spring of large, clean leaves, easily prepared for cooking. The cutting might be continued every few weeks all summer, as they continue to grow vigorously till the ground freezes late in the fall. They yield, on rich soil, large crops, nearly a bushel to the square yard. The older the roots the greater the crop. Time will tell how much longer they will grow and produce on the same roots, before they fail of old age. The Boston market has used the improved thick-leaved dandelion for years, by the car load, and when the market is overstocked they are canned and shipped to other markets, wherever the New England Yankee or his descendants can be found, and that means all over the world.

The market in Columbus now depends on the wild dandelion gathered from the fields and roadsides, among the grass and weeds. But now the cultivated, improved, thick-leaved dandelion has come to stay, and when it is introduced into our home gardens and truck farms, we shall have no longer to depend on wandering over the fields and roadsides to gather them. The seed is to be found in all the seed stores. It comes early into the market, and we have sold it to the dealers for 75 cents per bushel. It is a very healthy food, a tonic to a run-down system, and takes the place of quinine in medicine.

Some persons object to its bitter taste, but that can be greatly relieved by changing the water while cooking, or by mixing them with almost any other variety of greens. The green dandelion leaves can also be

used for salads without cooking. About fifteen years ago we raised them in the Atlanta (Ga.) University Garden (for the northern teachers' tables) from seed obtained of Gregory & Son, of Marblehead, Mass.

The cabbage is cultivated with more acreage in the Connecticut River Valley at the present time than tobacco, and will produce about 7,000 heads per acre, and the usual price for years back has been $5 per hundred, and in the aggregate, per acre, $350. Sweet corn, for table use, $160 per acre. Pop corn, $100 per acre.

The potato is cultivated by everyone having ground enough to be called a garden, and is in everybody's cellar, and on the table of the rich as well as the poor. The potato is certainly the most desirable of all roots for family consumption; 150 bushels per acre is considered satisfactory to the farmer, which at 75 cents per bushel amounts to $112.50 per acre.

The common English turnip is much despised, and the flavor is often tasted in the milk and butter, by exquisite purchasers of the same, whether the cows have ever eaten any or not. These same despised turnips are the most cheaply and easily raised of any of the bulbous roots. Four hundred bushels per acre is considered a good crop, which at 25 cents per bushel is $100.

The Swedes, or Ruta Baga, is a much larger and more desirable variety of turnip in quality, giving a much greater yield, and has the advantage of keeping in good condition late in the spring and early summer. Six hundred bushels is a fair crop, worth 50 cents per bushel, or $300 per acre.

Beets for table use yield 300 bushels per acre, and at 75 cents per bushel amounts to $225 per acre. Sugar beets and Mangle Wurtzle, a much larger variety, 600 bushels per acre, at 25 cents per bushel, amounts to $150 per acre.

Onions yield 500 bushels per acre; at $1 per bushel amounts to $500 per acre.

Parsnips will produce about 600 bushels per acre, worth 75 cents per bushel, being $400 per acre.

Carrots, 500 bushels per acre, often sold by the ton at the same price as good hay, for horse feed, but generally at 50 cents per bushel, or $250 per acre.

Beans, the common field bean, a dwarf variety, is calculated to yield 40 bushels per acre at a ready-selling price of $2 per bushel, or $80 per acre. But the pole bean, of the case-knife variety, far outstrips the dwarf variety. An acre planted in rows four feet apart and two feet in the row, contains 5,120 hills, and will yield one quart to the pole or hill, or 160 bushels per acre at $2 per bushel will bring $320 per acre. The cost of cultivating the pole bean is much more than the dwarf varieties, but the gain in the quantity of the crop far exceeds the extra expense of cultivation.

Winter squash holds an important place with other garden crops. A good crop would sell for as much as $80 per acre.

The "teasel," a good producing crop; used by all manufacturers of woolen goods to raise the nap on cloth for carding. We learned the market price was $6 per 1,000 heads, and a fair crop will produce 200,000 heads, amounting to $1,200 per acre. This being a biennial plant, we have $600 as the annual income per acre.

Sage is capable of yielding a ton per acre after the first year; at 50 cents per pound will amount to the extraordinary sum of $1,000 per acre annually.

In conclusion, we would say, and leave it where we began, that every man must decide for himself what crops he can raise with profit, and what crops his soil will produce with success by actual trial.—Journal of the Columbus Horticultural Society.

THE REPORT OF THE SECRETARY OF AGRICULTURE.

THE Year Book of the United States Department of Agriculture for 1900 has just issued from the Government Printing Office. The edition is 500,000 copies, so that all those who are particularly interested in the subject can easily obtain them through their Congressman. It is a curious fact that beginning with the earliest days of the Republic, Government officials, including officers of the Army and Navy and Consuls, together with private citizens, interested themselves in importing plants and animals for the general benefit. Congress began to help in 1839 by appropriating $1,000 to be expended by the Commissioner of Patents, after which time the enterprise grew steadily year after year until 1862, when Congress grouped the various branches of the work into a department under a commission. Since 1888 the department has been in charge of secretaries who have effected more complete organizations of bureau and division staffs. These are now in intimate touch with producers throughout the land.

The present incumbent of the office of Secretary aims to bring the scientists of the department to the assistance of the producer, to ascertain if what we import may not be produced in our own country, and to encourage the growth and development of our agricultural industries, and to search the world for grains, fruits, vegetables and grasses that may be domesticated here and be an improvement on what we have; to secure new varieties of plants by cross-fertilization, that we may by selection establish new hybrids; to co-operate with the experiment stations of the states and territories in research valuable to the people in all sections of the country; and seek new markets that our surplus products may bring better rewards to the husbandman. The Department of Agriculture differs from all others. Appropriations for its use are investments. It makes direct returns by adding to the wealth of the country. The Weather Bureau has become a necessity to mariners, fruit growers, and others. Meat inspection insures public health and keeps open doors for us in foreign countries that are satisfied with the excellence of our supervision. The orange industry in California and Florida dates its beginning and preservation to this Department. The service of the entomologists are worth more to the people than the total expense of the Department.

The Weather Bureau was directed to systematically investigate the various methods of electrical communication without wires. New appliances have been devised for the transmission of signals, and receivers have been constructed that are probably more delicate than any heretofore made. Messages have been already successfully transmitted and received over fifty miles of land. It is hoped in time that the craft employed in the coastwise commerce of the United States and over its great inland seas will be placed in instantaneous communication with the numerous stations of the Weather Bureau. Another important addition to the work of the Weather Bureau in the near future will be the beginning of special storm forecasts for the North Atlantic Ocean, a step made possible both by the use of reports received from the West Indies, the Bahamas, Bermuda, and those to be received from the Azores and Portugal through the new cable system connecting Lisbon, the Azores and New York. Arrangements have been made already by which daily observations will be received from Great Britain and France. It is intended to make forecasts of wind force and of wind direction for the first three days of the route of all outgoing steamers and for an equal period for such as place themselves in communication with the Weather Bureau before leaving European ports. The value of the West Indies Meteorological Service, incorporated in 1898, has several times been demonstrated, notably in the case of the hurricane that devastated Galveston, when the storm was detected at its inception. Its location was daily plotted and its course and its intensity successfully forecasted for eight days before it reached the Texas coast. It is a significant fact that, notwithstanding the great number of craft plying in the Gulf of Mexico and the Great Lakes, the warnings were so timely that there was no disaster upon the open waters.

The Bureau of Animal Industry has been doing remarkable work during the year. The total antemortem inspections of cattle aggregated 53,087,994; the total number of post-mortem inspections was 34,737,613. The work of preparing serum for treating hog cholera and swine plague has been continued. The Bureau has also been active in the detection of tuberculosis in cattle.

The Division of Chemistry has continued during the past year its elaborate work in the investigation of the extent and character of food adulteration and the composition of foods. The principal study during this period has been of the composition and adulteration of preserved meats, a subject in which the whole country has lately taken particular interest. The Division finds that so far as can be discovered horse meat is not offered for sale in any part of the United States under its own name, and it is believed that very little of it is sold under any other name. The study of soil bacteria has been continued with results which are of the most encouraging nature with regard to practical agriculture.

The Division of Entomology has carried on its valuable work. The Smyrna fig industry promises to be of large importance, and the insect which fertilizes the fig has been successfully carried through the winter, and during the summer it has been cared for with such good results that in one locality in California more than six tons of Smyrna figs of the highest grade of excellence have been produced and packed. The direct result of the importation and establishment of this insect will be to make America a strong competitor in the dried fig trade in the world's markets. An important parasite has been imported from Africa which preys upon the olive scale. A fungus disease of grasshoppers has been imported from Natal which has destroyed injurious swarms of locusts in Colorado and Mississippi. Dr. Howard is endeavoring to introduce European parasites of the gypsy moth. Important work has been carried on against insects damaging forests in the far northwest and in the woods of Maine. The recent publications of the Division on the subject of mosquitoes have been greeted by medical men of this country with decided approval.

The Division of Botany has tested a large number of samples of seeds. Plants poisonous to stock have also been investigated, as well as the economic plants of the tropics. The Section of Seed and Plant Introduction has imported valuable cereals, grasses, forage plants, vegetables, rice, etc. The Division of Vegetable Physiology and Pathology has carried out important work in plant breeding, the breeding of a new variety of corn, the improvement of cotton and tobacco. The Divisions of Pomology and Agrostology also accomplished important work during the year. The Division of Biological Survey has carried on field work in a number of states and territories with the intention of outlining life zones. Much interest in the Belgian hare has been developed during the last three years. The introduction of these animals is accompanied by a certain element of danger. Stringent measures may be required to keep them under control. The State Board of Horticulture of California has estimated that several thousands of the animals are already at large in the State. The study of the food of birds and bird protection is a most interesting one, and the Lacy Act gives the Department large powers.

The Division of Soils has continued and considerably extended the investigation and mapping of the soils of some of the important agricultural districts of the United States. The total area surveyed and mapped amounts to 2,160,000 acres. The tobacco investigations carried on by this Division have been very productive of good. The Sumatra leaf tobacco which has been planted in Connecticut has been most satisfactory. The leaf produced has been so fine that the New York tobacco men say that it cannot be told from the imported leaf, and they predict, as a result of this work, a complete revolution in the tobacco industry of the Connecticut Valley. We import annually 40,000 bales of Sumatra tobacco, nearly $6,000,000 being paid annually to foreign producers. It is believed that in a very short time we will be able to save this money for our own producers. Experiments are now being made in the improvement of the flavor and aroma of the filler tobacco of Pennsylvania and Ohio.

The work of the Division of Forestry continues to be thoroughly practical. The demands for expert services are insistent, and the inability of the forester through lack of resources, to meet these demands is perhaps the most serious of all hindrances to the progress of practical forestry in this country. The total requests for working plants amounted, at the end of the last fiscal year, to 51,192,714 acres. There is much inquiry in all sections of the United States regarding better roads and better methods of building them. The United States has been divided into four sections, and an expert agent has been appointed to each of these sub-divisions. The office of the Public Road Inquiries has been active in the last year in co-operating with people in the several states in the building of experimental roads, as well as with agricultural and other colleges and associations that are interested in this work.

The work of the Experiment Stations during the past year has been for the most part along the same lines as heretofore, and in the aggregate a large amount of useful work has been accomplished. The work of the Division of Publications necessarily grows step by step with the growth of the Department at large. It is a flattering tribute to the work which is being done that last year the largest number of copies of all publications aggregated considerably over 7,000,000, but the refusal to applicants was at least ten times more numerous than six years ago.

Our total sales of domestic farm products to foreign countries during the four fiscal years 1897 to 1900 aggregated the enormous sum of $3,186,000,000, or close to $800,000,000 in excess of the export value for the preceding four-year period. The agricultural exports of the United States for the fiscal year ending June 30, 1890, amounted in value to $844,000,000, exceeding all other records except the phenomenal one of 1898, when a valuation of $859,000,000 was attained. Notwithstanding the valuable nature of the work done by the Department, the appropriation for the fiscal year 1900 was only $3,006,022.

THE DEVELOPMENT OF THE CHICK.*

TO-NIGHT I want to describe the embryology of the chick as an example of one animal's development, proceeding from a comparatively simple condition (the egg) up to the adult; for until we know the factors of the development of the individual we cannot at all begin to understand the factors of the development of different races.

The first worker on the embryology of the chick was William Harvey, the discoverer of the circulation of the blood and one of the greatest physiologists of all time. Harvey wrote a little work in Latin on the development of the chick which is still very full of interest and is frequently referred to, on account of its great accuracy, by modern workers in embryology.

In the embryology of the chick we find a development inside of an eggshell, which has greatly modified the development. Eggshells are not primitive structures, but distinctly additional, new formations which have modified and changed the development to make the embryo adapt itself to a life within the shell. In the shell the embryo has no chance of swimming nor of using gills; so it is adapted in other directions, the principal one being due to the circumscribed space for the young chicken to grow in, namely, folding of the parts of the embryo.

Of the chicken's egg as we see it, only a very small part is the real egg. In the egg as it is first forming in the hen is a portion known as the yolk, with, at one pole of it, a little disk, the germ disk, which is going to become the embryo. As the egg passes down the oviduct of the hen there is added to it first of all a gelatinous layer of white albumen; and then around that is afterward formed the shell.

The first change which occurs in the germ disk is its breaking up into a large number of cells. There is one cell at the start—a fertilized egg-cell; this then by a number of cleavage lines passing through it divides up into a number of cleavage cells; and the result of the cleavage process is the formation of thousands of cells. They arrange themselves into a lower layer of larger cells and an upper layer of smaller ones, these being the primary germ layers.

From that lower germ layer arise the intestines and lungs; from the outer one the skin, the sense organs and the central nervous system. Coincidently there differentiates another cell layer, known as the middle germ layer, and from that develop the muscular and skeletal systems. The transformation in these layers consists in an increase in the number of cells, in their becoming differentiated from one another, and in a great infolding of them.

There is first a folding downward of the outer layer and a folding upward of the lower layer; and then the middle layer splits into two layers. The bending in of the outer layer gives rise to a tube which becomes the brain and the spinal cord. The tube that bends in from the lower layer becomes the intestine. From the walls of the two membranes caused by the splitting of the middle layer will be formed the heart and the greater part of the muscles of the body.

From the anterior region of the brain there grows out at a very early period a vesicle—the optic vesicle. The next change is a bending in of the tip of the optic vesicle to form a cup, which later becomes the retina of the eye. Just opposite this retina there is a thickening of the outer germ layer; first a simple thickening which becomes an open cup, and that cup cuts off as a little hollow sphere. That is the first beginning of the lens of the eye. These are the two most important parts of the eye already at an exceedingly early stage, a part that has grown out from the wall of the brain to become the retina, and the lens that has cut off from the skin. The further changes in the eye are principally these: The retinal portion becomes much larger and its stalk much shorter, the stalk becoming the optic nerve. The retina is composed of two layers, one of which becomes the pigment layer, the other the light-perceiving area. The lens that is cut off from the skin increases in size, flattens, and gradually becomes solid. From the middle germ layer arise the iris, the vitreous humor, the thick outer coats of the eyeball and of the optic nerve, and the eye-muscles.

* A lecture delivered in the course on Evolution at the Wagner Free Institute of Science, Philadelphia, by Prof. Thomas H. Montgomery, Jr., of the University of Pennsylvania. Specially reported for the SCIENTIFIC AMERICAN SUPPLEMENT.

The nose has a somewhat similar development, but it is simpler, there being no lens in the nose. Two nasal pits formed by the outer skin are joined by outgrowths from the brain; the latter become the olfactory or nasal nerves and the former the nostrils.

The ear is developed back in the region of the primitive hind brain, as a cup-shape invagination of the outer germ layer. This cuts off and becomes a perfect sphere, and then there is formed on its inner side a nerve ganglion which sends off the auditory nerve to join the brain. The ear vesicle divides into two parts, an upper and a lower, by a partition that grows across. From the upper part the three semicircular canals arise, and from the lower part the cochlea.

The hollow tube that forms the intestine gives off from its upper side a solid rod of cells, known as the notochord, or the dorsal chord of the embryo, which is the most primitive skeleton; this is the supporting structure around which the vertebral column is going to arise. Later, in the head region there break through on either side of the intestine three pairs of openings known as the gill-slits, and afterward the mouth opening forms by the intestine joining with the skin. The chick does not breathe by these gill openings at all, so that we shall return to the reason for their existence. During all this period the embryo has been bending so that the head comes close to the tail, this bending, which is most pronounced in the head region, being occasioned by the restriced space within the eggshell.

The muscles of the chicken in the adult stage are not segmented, though the vertebral column is; but there is at an early stage in the chick a segmentation into a series of muscle segments arranged along the whole back. These are paired, one at each side, in the same plane of the embryo, and represent an interesting ancestral condition.

We have so far considered only the germ disk. While the germ disk is lying upon the yolk it is not uncovered, but enveloped by characteristic membranes which grow up to cover it. If there were no such protection for it, the chick would injure itself against the hard inner surface of the eggshell; to obviate that, membranes develop to give us a soft cushion for the embryo. The outer and middle germ layers grow up in a circle around the embryo, and finally the edges of this elevation grow together so as to form a closed sac around it. The space between that membrane composing the wall of the sac and the embryo is filled with a thin fluid to serve the purpose of the stuffing of a cushion.

Embryos developed in a soft, slimy mass as snails do would have no need of such a cavity filled with fluid; but the chick digests very fast all the yolk substance and albumen around it, so that such a protective membrane is necessary. These envelopes do not enter into the body of the adult chicken at all; they are purely temporary, to protect the chick. Then we find a temporary breathing organ formed. At the larger end of the eggshell there is always an air space to serve for respiration. An apparatus for breathing has to be formed during the early stage because the gills are not functional, and the lungs not yet developed. A large double-layered sac grows out from the lower side of the embryo; into that sac are discharged all the excreted products of the embryo, and at its surface respiration is accomplished.

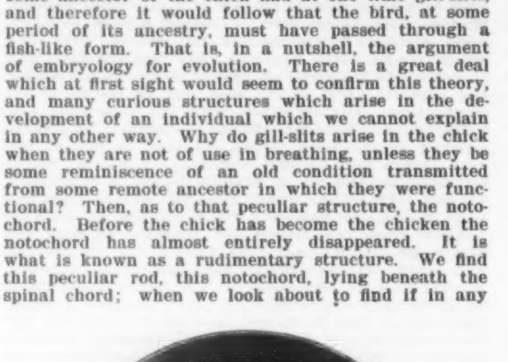
When the chick is ready to hatch, there is a loss of both of these sacs, and the greater amount of the yolk has been taken up as food.

Now, what I would call your attention to is the formation of a very complex animal from a very simple egg-cell. First cleavage cells arise, these increase in number and arrange themselves into tissues, the kinds of tissues multiply and become more specialized, and by complex foldings the various organs are produced. A chick develops out of what was originally apparently a very simple mass of substance.

But was that a simple mass of substance? Are there in the egg-cell, long before these organs are developing, all the rudiments of all the parts that are to form? Or are such rudiments not present? We cannot yet give the answer to that question. Either each future organ is represented by a germ in the egg, which is known as preformation; or else there is no such preformation but the inherited tendency to develop under the stimulus of external forces. This is one of the great problems of development. We can say, of course, that there are no distinct organs inside the egg-cell at the beginning; but may there not be parts that will represent those? That is the question.

What light does the development of the chick throw upon the development of the race? We can consider in a chick the evolution from the egg up to the adult, which is the development of one individual of the species. Does that throw any light at all on the development of birds in general, as to what the chick's ancestors had been? We find that there has arisen in Germany a great school of workers under the leadership of Haeckel. Haeckel took up evolution from the standpoint of embryology, and maintained that the whole process of individual development shows that the race itself must have undergone a development; that is, since the individual passes through successive stages, then the race must have passed through successive stages. That is what is known as the historical method of evolution; that is, studying the history of racial development and not the factors. Let us look at some of the points in this doctrine to determine what there is in it that has held itself through time and through the debates that have come upon it, and what has had to go down before the discussion.

Von Baer put forward the question, when he found in every chick gill-slits appearing, and when he saw that the young chick does not use them for breathing, what is the value of these gill-slits? Then he advanced the idea which is now called the biogenetic law: the development of the individual is the repetition of the history of the race. What he meant by that is, that a history of the successive stages that a chick passes through would correspond to the successive stages that the race had passed through. Now, he said, we find appearing on the young chick at an early stage, gill-slits; that, he said, must show that some ancestor of the chick had at one time gill-slits, and therefore it would follow that the bird, at some period of its ancestry, must have passed through a fish-like form. That is, in a nutshell, the argument of embryology for evolution. There is a great deal which at first sight would seem to confirm this theory, and many curious structures which arise in the development of an individual which we cannot explain in any other way. Why do gill-slits arise in the chick when they are not of use in breathing, unless they be some reminiscence of an old condition transmitted from some remote ancestor in which they were functional? Then, as to that peculiar structure, the notochord. Before the chick has become the chicken the notochord has almost entirely disappeared. It is what is known as a rudimentary structure. We find this peculiar rod, this notochord, lying beneath the spinal chord; when we look about to find if in any



EMBRYO OF THE CHICK.

group of animals in the adult stage there is a persisting, functioning notochord, we find it in the sharks and also in the Amphioxus, in which it is the functional skeleton. The argument from embryology would show that the chick by virtue of having the notochord must have had some ancestor in which the notochord was very much more developed than at present, and that would be another point speaking for the fish-like ancestry of the birds.

This method of argument is a very interesting one, and yet, in another way, it can lead us to a great deal of confusion and a great deal of error. If we say that every structure which appears in an embryo has at some time been represented in the history of an ancestor of that embryo, we should have to conclude structures present in the ancestor which probably never occurred there at all. Just to take one case, the protective membrane developed around the chick could not have been present in the adult stage of an ancestor. Birds have an eggshell, and the reptiles, which we have very good reason to believe are the birds' immediate ancestors, have an eggshell; but we do not find a hard, thick eggshell in any fish, or any amphibian, so this must have been a new character. The embryonic respiratory sac of the chick is not found in the fishes nor in the sharks—animals which other reasons would give us to suppose were the ancestors of the chick; so this must be a new character. This is what is called the falsification of the embryological record. Any embryo in its development may show structures which will give a clew to the ancestry; but it may show also a great many other structures which so falsify that record that it is almost impossible to separate the true from the false. The gill-slits we say are ancestral, and the notochord also; yet there are other structures which are not ancestral. How can we be sure what is ancestral? No one yet has, and no one ever will, see a bird developing out of a fish-like ancestor. It is a process taking an enormous amount of time. We have indirect reason to believe in such an ancestry; but the reason we have, it seems to me, is not the reason furnished by embryology. I would not belittle in any way the importance of the biogenetic law. It has been the working theory which has more stimulated the whole work of evolution than anything else. Before it was formulated and elaborated, embryology was nothing but a mass of facts seeming to have no connection with one another. But then came the search for the ancestry; biologists wished to get clews to the evolution of races; and then a way was opened out in the theory, "the steps in the evolution of the individual will be found to correspond to the steps in the evolution of the race." The objection to this deduction is that the record in the embryo can be easily falsified by new structures not present in the ancestors.

REPTILES OF FRENCH GUIANA.

AMONG some reptiles recently received from French Guiana by the Museum of Natural History of Paris may be mentioned a specimen of one of the largest lizards that inhabit that country. This lacertian is the "Salvator" (*Tupinambis nigropunctatus*). It owes its popular name to the fact that it produces a very peculiar whistling sound when it discovers a rattlesnake or an alligator, and thus makes known the approach of these dangerous reptiles. The one that reached the Museum is nearly three feet in length and is a superb specimen.

Dumeril and Biberon tell us that the salvators in the wild state seek honey, and that in order to obtain it without being attacked by the bees, they run up to the hive several times and strike it with their tail and then run away again, and so proceed until they have driven the busy inhabitants from their domain.

The flesh of the salvator, like that of the iguana, that large, crested lizard of Guiana and Brazil, is succulent, and several Europeans who have eaten it say that it is very delicate. Its eggs, which are quite large, oval and a little longer than a hen's egg, are likewise sought for as food.

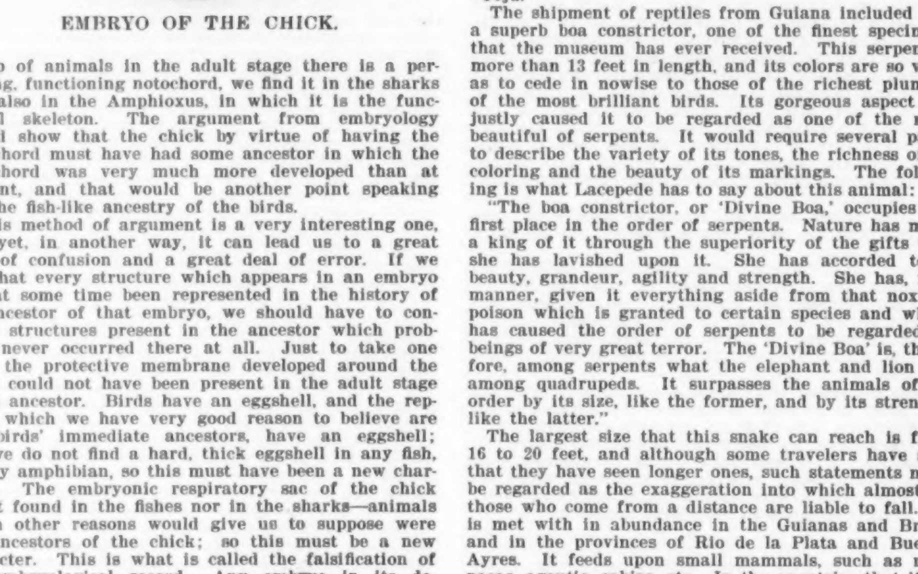
The natives call the animal "Tejuguaçu" or simply "Teju."

The shipment of reptiles from Guiana included also a superb boa constrictor, one of the finest specimens that the museum has ever received. This serpent is more than 13 feet in length, and its colors are so vivid as to cede in nowise to those of the richest plumage of the most brilliant birds. Its gorgeous aspect has justly caused it to be regarded as one of the most beautiful of serpents. It would require several pages to describe the variety of its tones, the richness of its coloring and the beauty of its markings. The following is what Lacepede has to say about this animal:

"The boa constrictor, or 'Divine Boa,' occupies the first place in the order of serpents. Nature has made a king of it through the superiority of the gifts that she has lavished upon it. She has accorded to it beauty, grandeur, agility and strength. She has, in a manner, given it everything aside from that noxious poison which is granted to certain species and which has caused the order of serpents to be regarded as beings of very great terror. The 'Divine Boa' is, therefore, among serpents what the elephant and lion are among quadrupeds. It surpasses the animals of its order by its size, like the former, and by its strength, like the latter."

The largest size that this snake can reach is from 16 to 20 feet, and although some travelers have said that they have seen longer ones, such statements must be regarded as the exaggeration into which almost all those who come from a distance are liable to fall. It is met with in abundance in the Guianas and Brazil and in the provinces of Rio de la Plata and Buenos Ayres. It feeds upon small mammals, such as rats, pacas, agoutis, cabias, etc. In the countries that it inhabits it renders genuine service by clearing the houses and stores of the rodents that swarm therein. It does not attack man, and so, far from dreading it, the inhabitants have no fear of sleeping in rooms into which it has chanced to enter. It is, in fact, almost a domesticated animal. It is, moreover, of a very gentle nature, and it is for this reason that it is selected by preference by showmen for exhibition at fairs.

This is the species that, in menageries, has the habit



THE "SALVATOR"—TUPINAMBIS NIGROPUNCTATUS, SPIX.

of swallowing the blanket that is placed in its cage in order to increase the heat of it. Everyone knows the story of the 10 foot serpent that one fine day swallowed a 6.5 x 5.25-foot blanket and kept it in its stomach for a month. At the end of this time the snake opened its jaws, and a keeper, perceiving the extremity of the blanket, seized it and pulled out the undigested mass. The blanket had assumed the form of a roll about six inches in diameter. After this effort our boa remained as if dead for a fortnight, and then completely recovered and lived for some time as if nothing had happened.

We now come to two other serpents comprised in the shipment, and which are no less interesting than the preceding. One of these is the *Bothrops atrox* and the other the *Lachesis mutus*, two species closely related to the famous "Fer de Lance" of Martinique. As the *Bothrops* and *Lachesis* are closely related species, we shall speak only of the latter, which is the more formidable.

This species of the family *Crotalidæ* attains a length of from 6.5 to 8.25 feet. It has been known for a very long time, and several authors have described it under the name of *Cophias surucucu*, *C. crotalinus*, *Crotalus mutus*, *Boa muta*, *Scytale catenata*, *S. ammodytis*, *Lachesis muta* and *Trigonocephalus rhombiatus*. Its coloring is very bright. The upper part of the body is of a reddish yellow and marked with large lozenges of a very dark brown. The top of the head is marked with irregular figures of a dark maroon. A black stripe starts from the eye and runs along the side of head as far as to the occiput. The belly is of a pale yellowish white. The scales of the body are carinate. The head is very flat and projects in the rear. The poison glands are greatly developed and the fangs are formidable by reason of their size.

As above stated, it belongs to the family of *Crotalidæ*. Its conformation, in fact, allies it to the rattlesnake, with the difference that its tail is not provided with rattles. It was precisely on account of the absence of these horny and sonorous pieces that Linnæus gave it the specific name of *mutus* (mute). The name *Lachesis* and that of *Atrops* of the related species are borrowed from the cruel Fates of mythology.

The nature and effects of its poison differ from those of its cogener, for, despite the reputation of the *Crotalus*, several travelers worthy of credence have stated that they have seen natives bitten by this reptile and not die, while the bite of the *Lachesis* is almost always mortal, and kills the largest animals in a very short time. Finally, the *mutus* is the largest, strongest and most audacious of the venomous serpents of America. So it is very much dreaded in Guiana, and especially in Brazil, where it abounds.

The natives use its venom to poison their arrow heads. The old pharmacopæia employed it against certain diseases, such as cholera, plague, etc., but since the use of the remedy caused more accidents than cures, it was abandoned. Homœopathic medicine, however, has for some years past been using the substance in the treatment of cardiac affections. For the above particulars and the engraving we are indebted to La Nature.

THE TREASURE FOUND AT BOSCOREALE NEAR POMPEII.

ONE of the most interesting discoveries made at Pompeii within recent years is that of the Roman villa Boscoreale, with its frescoes and mosaics. The excavation of the villa also brought to light a collection of silverware of different forms and high artistic value. The greater part of this collection was acquired by the Baron de Rothschild and presented by him to the Louvre. Boscoreale is about two miles north of Pompeii and to the southeast of Vesuvius, occupying a somewhat elevated site. In digging the foundations of a wall the existence of ancient constructions was made evident as early as 1876, but it was not until 1896 that the present excavations were carried out by M. Vincenzo de Prisco. It was found that the constructions formed a regular ensemble measuring 130 feet long by 80 wide, and this proved to be a villa or farm house, containing two main parts, one consisting of the dwelling house proper and the other of the various buildings for the production of wine. The walls of the dwelling house are built of cut lava alternating with layers of brick, while for the other buildings the spongy sarno and ancient materials are used, among which are found debris of cut marble. The villa is ornamented with handsome frescoes, which are very well preserved. Some of these represent landscapes with houses of several stories; it is interesting to remark that in the excavations of Pompeii no constructions of this character have been found. Different panels represent flowers and fruit, and one large panel has a group in which a gladiator and a youth are listening to a woman playing upon the lyre. The floors of the rooms are in mosaic, and the finest of these has a dragon for the principal subject. The villa and outbuildings are surrounded by a wall; great earthen vases, used for storing the wheat, may be seen. Those which are still intact are found planted upright in the ground. A large circular metal basin, upon a stone support, is also to be remarked. In the inclosure of the villa were found a great number of utensils, and at the left of the entry, near the porter's lodge, a dog was found dead at his post; his stretched chain shows the efforts he made to escape the peril. The collection of silverware which forms the most important of the objects was found in the wine reservoir, and it seems to be clearly indicated that the pieces were carried to this hiding place at the time of the eruption; nearby was found the body of the man supposed to have carried them; he had fallen upon his hands and knees with his face to the ground. At his sides were found four gold bracelets, besides earrings, a chain and about a thousand pieces of gold coin, whose effigies form a complete series from Augustus to Domitian; the latest piece is of the year 76. The gold has not been appreciably altered, but the silver pieces were blackened and some of them were covered with a sulphurous deposit; the handles and feet of most of the vases had become detached.

This collection was put on sale and the price of $100,000 was asked. The French government offered only $50,000, but the Baron de Rothschild bought for $80,000 95 pieces of silverware, which he presented to the Louvre; other gifts have increased the total number of pieces at the Museum to 102. Two of the finest of these pieces are shown in the engravings. The first is a patera formed of two parts, a central medallion in high relief and an outer rim with an engraved border of leaf design. The medallion represents the city of Alexandria, which is personified by a woman shown in bust with the head strongly projecting. A head-dress

SILVER PITCHER FROM THE TREASURE OF BOSCOREALE.

of strange character represents the trophy of an elephant, whose trunk and tusks curve upward in front, while the ears fall down at the sides of the head. The ears of the woman are pierced with small holes, from which were no doubt suspended earrings of gold which have not been found. The figure holds in the right hand the *uræus*, or sacred serpent, emblem of the divinity and of the royal dignity of Egypt. In the center are different emblems, such as fruit, a peacock, an ear of wheat, and to the left is a female panther facing the serpent. The left hand holds a cornucopia ornamented

ALEXANDRIAN PATEN—TREASURE DISCOVERED AT BOSCOREALE.

with a relief design and containing grapes and pomegranates surmounted by a crescent. A lion in relief rest upon the right shoulder, as guardian of the city. The central medallion was gilded, with the exception of the flesh parts, and traces of the gilding still remain. The repoussé work of this piece is of an extraordinary character and its preservation is perfect. The medallion has a diameter of 6 inches, and the whole piece 9 inches; it weighs about 24 ounces. Two important pieces are a pair of wine vases, one of which is shown in the engraving. It is ornamented with a subject representing the Victories sacrificing before the altar of Minerva. The neck of the vase has an infant, or genius, terminating in leaf design offering a cup to a griffin; this design is repeated on the other side of the neck. A border separates it from the lower part; a statue of Minerva, with drapery and casque, occupies the middle of the design (seen in profile to the right), standing upon an altar decorated with emblems. The right hand carries a round shield and the left a spear. One of the Victories is shown in the act of sacrificing a deer, and that of the opposite side is seated upon a ram and holds a laurel branch. The vases, excepting the flesh parts, were also gilded. Their height is about 10 inches and weight 22 ounces. The collection contains a great number of interesting pieces, many of which have a high artistic value, including bowls, pitchers, drinking vases and cups, besides two mirrors with fine ornamentation. Among the small pieces are round salt cellars with feet, spoons and wine strainers.

[Continued from SUPPLEMENT, No. 1332, page 21345.]

THE SEA BOTTOM—ITS PHYSICAL CONDITIONS AND ITS FAUNA.*

HAVING discussed the physical conditions under which the animals of the deep sea exist, let us now turn our attention to the animals themselves.

Personally, I may say that nothing regarding the animals dredged from deep water has impressed me more than their colors. It seems an unquestionable fact that they live in practical darkness, and one naturally expects them to be colorless.

Now we know of a considerable number of animal forms that certainly do live in utter darkness in the subterranean waters of extensive caves, such as Mammoth or Wyandotte Caves. These animals have been very carefully studied, especially by my friend Dr. Eigenmann, of Indiana University, who tells me that true cave species are always practically blind and colorless. But the animals brought up from the deep waters of the ocean are often very brightly and conspicuously colored.

The question at once arises: What is the significance of these colors? Are they merely fortuitous, or have they a meaning that can be deciphered, giving a clew that may lead to a further understanding of the mysterious realm beneath the waters? It is my purpose this evening to attempt to answer these questions, but before doing so let us examine briefly the main facts regarding the colors of abyssal animals. We will call as witnesses some of the naturalists of the widest experience in the science of thalossography, and supplement this evidence by facts of personal observation.

Professor Mosely, of the "Challenger" staff, says: "Peculiar coloring matter giving absorption spectra has now been found to exist in all the seven groups of the animal kingdom. The Echinodermata and Cœlenterata appear to be the groups which are most prolific in such coloring matter. Pentocrinin and antodonin seem to be diffused in immense quantities throughout the tissues of the crinoids in which they occur and the Echinoderms generally seem to be characterized by the presence of evenly diffused and abundant and readily soluble pigments." Again, he says: "The same coloring matters exist in the deep-sea animals which are found in shallow water forms."

Alexander Agassiz, than whom no living man has had more experience in deep sea work, says: "There

* Lecture delivered before the Nebraska Chapter of the Society of the Sigma Xi, February 14, 1901, by Prof. C. C. Nutting, of the State University of Iowa, and published in Science.

are many vividly colored bathyssal animals belonging to all classes of the animal kingdom and possessing nearly all the hues found in living types in littoral waters. . . . There is apparently in the abysses of the sea the same adaptation to the surroundings as upon the littoral zone. We meet with highly colored ophiurans within masses of sponges themselves brilliantly colored at a depth of more than 150 fathoms. . . . While we recognize the predominance of tints of white, pink, red, scarlet, orange, violet, purple, green, yellow and allied colors in deep water types, the variety of coloring among them is quite as striking as that of better known marine animals. . . . There is as great a diversity in color in the reds, oranges, greens, yellows, and scarlets of the deep-water starfishes and ophiurans, as there is in those of our rocky and sandy shores. . . . Among the abyssal invertebrates living in commensalism the adaptation to surroundings is fully as marked as in shallow waters. I may mention especially the many species of ophiurans attached to variously colored gorgonians, branching corals and stems of *Pentacrinus* scarcely to be distinguished from the part to which they cling, so completely has their pattern of coloration become identified with it. There is a similar agreement in coloration in annelids when commensal upon starfishes, mollusks, actiniæ or sponges, and with crustacea and actiniæ parasitic upon gorgonians, corals, or mollusks. The number of crustaceans . . . colored a brilliant scarlet is quite large."

Professor Verrill, of Yale University, in his report on the ophiurans collected by the Bahama expedition from the University of Iowa, repeatedly calls attention to the agreement in color between these animals and the forms upon which they grow.

My own observations fully confirm those of the naturalists just quoted. Among the crustaceans were many species colored a bright scarlet, and one was an intense blue. The echinoderms were particularly striking in their coloration. Yellow and purple Comatulæ abounded in deep water near Havana. Serpent stars were brown, white, yellow, red, purple and deep violet. A basket fish, colored chocolate brown and vivid orange, was abundant off the Florida Keys. There were sea urchins with crimson and white spines; another particularly gorgeous one had a test with alternating zones of chocolate and orange, and spines barred with carmine and white. The cœlenterates told the same story, but it is unnecessary to multiply further the evidence. Enough has been given for our purpose, which was to demonstrate the existence of bright colors in considerable quantities in the deep waters of the ocean, and we feel justified in making the following general statements regarding these colors:

1. The colors are often as brilliant as in shallow water.

2. The reds, orange, yellows, violet, purple, green and white predominate.

3. The colors when present are usually in solid masses in striking contrast, or else the whole animal is brilliantly colored. Fine patterns are very scarce, and nature seems to have used a large brush in adorning her children of the depths.

Now let us return to our question: What is the significance of these brilliant and varied colors?

I must confess to being a Darwinian of the strict constructionist school, and believe fully in the doctrine that no animal possesses any character, including color, that is not of use to the species to which it belongs, or has not been of use to the ancestors of that species. It is my conviction that if we knew all the circumstances surrounding the past history and present life of any animal, we could explain on the score of utility every character, using the word in the zoological sense, possessed by that species. And it is my purpose to use the coloration of deep-sea animals to illustrate this law.

In my opinion, the presence of all these colors can mean but one thing, and that is that there is light even in the deepest depths of the ocean. Or, to state the matter in another way, if we can prove the presence of light in considerable quantity at the bottom of the sea, the colors of its inhabitants become entirely explicable. We can then explain them as we do the colors of the animals of shallow waters, regarding the colors as protective, aggressive, alluring, attractive, directive, and so forth, as the case may be.

There is another line of evidence tending to prove the presence of light at the sea bottom, and this is the fact that most of the vertebrates inhabiting the depths have functional eyes, often more highly developed than in shallow water, and only exceptionally are the eyes aborted or absent. Dr. Alexander Agassiz has the following to say on this point:

"We should not forget, on the one hand, that blind crustacea and other marine invertebrates without eyes, or with rudimentary organs of vision, have been dredged from a depth of 200 fathoms, and, on the other, that the fauna as a whole is not blind, as in caves, but that by far the majority of animals living at a depth of about 2,000 fathoms have eyes either like their allies of shallow water, or else rudimentary or sometimes very large, as in the huge eyes developed out of all proportion in some of the abyssal crustaceans and fishes."

And Professor Verrill says: "That light of some kind and in considerable amount actually exists at depths below 2,000 fathoms may be regarded as certain. This is shown by the presence of well-developed eyes in most of the fishes, all of the cephalopods, most of the decapod crustacea, and in some species of other groups. In many of these animals the eyes are relatively larger than in the allied shallow-water species."

In view of the almost uniformly blind condition of cave animals on the one hand, and of the well-tested Darwinian doctrine that useless structures, unless rudimentary, do not exist, on the other, I think we are justified in saying that a study of the coloration of the deep-sea animals, in connection with the general presence of functional eyes, is reasonable proof that light in appreciable quantities exists even at the greatest oceanic depths.

This being granted, we naturally turn to a consideration of the question: What is the nature of this abyssal light?

As already intimated, it is incredible that sunlight could penetrate in appreciable quantities to any such depth as 2,000 fathoms or over, or even to one-tenth of that depth, notwithstanding the theory advanced by Verrill, who seems to consider the presence of sunlight necessary to explain the facts of coloration. I think we are safe in assuming with Agassiz that at 200 fathoms the light from the sun is possibly that of a brilliant starlight night, and we are also justified in concluding that coloration would be useless in such a light. Did you ever notice how little of color can be seen even in the clearest moonlight night?

Sunlight being out of the question, is there evidence of any other light that would satisfy the conditions of coloration and organs of vision already referred to?

I have, on other occasions, sought to collect the evidence of the existence of abyssal light, and to determine its nature and function in the life economy of the deep sea. These efforts resulted in the belief that the light sought for is a phosphorescent light, and that it is adequate to explain the phenomena already discussed in connection with the colors of deep-sea animals.

This idea has been suggested before by several writers, notably by Andrew Murray, of the "Challenger," but it has heretofore been only a suggestion which no one has taken the pains to seriously investigate. It will be of interest, therefore, to consider the extent to which phosphorescent life is characteristic of the deep sea.

For the purpose of the discussion we will divide the animals of the sea bottom into two classes, the free swimming and the fixed forms.

Considering the free swimming forms first, we find among the fishes several allied to *Lophius* and *Antennarius*, which are provided with a bait said to be luminous, which serves to attract the prey. Others are luminous along the lateral line in definite spots. The utility in this case is not certainly known, but two suggestions may be made, one to the effect that the light attracts the mate and thus serves the purpose of attractive coloration; the other that it attracts the prey and serves the purpose of alluring coloration.

A very large number of crustaceans are highly phosphorescent. Many of these have large eyes and are particularly active in movement and voracious in appetite. They feed on minute organisms for the most part, and it can hardly be doubted that they often use their phosphorescent powers for the purpose of illuminating their surroundings and revealing their prey. Here again it is probable that the strangely attractive power of light serves a definite purpose in the life economy of the animal.

Among the mollusca we have few instances, so far as I know, of phosphorescent organs. At the Detroit meeting of the American Association for the Advancement of Science, Professor William E. Hoyle, of England, read an exceedingly interesting paper on certain organs possessed by cephalopods secured by the "Challenger." These organs were regarded as phosphorescent by Professor Hoyle, who described a highly specialized apparatus designed to reflect light from the phosphorescent bodies downward to the bottom over which the animal passed. In this case it appears that there is not only a light, but also a reflector, an efficient bull's-eye lantern for use in hunting through the abyssal darkness. Among the worms are many forms possessing a high degree of light-emitting power, which may be either attractive, alluring or directive in function, and thus of direct advantage to its possessors.

Most of the echinoderms, although not truly fixed, are not capable of rapid locomotion, and we are, therefore, not surprised to find few references to phosphorescence in connection with them. Perhaps the most active of this group are the serpent stars, and it is interesting that the only account that I find of phosphorescence in the echinoderms is Agassiz's description of a serpent star, which he says "is exceedingly phosphorescent, emitting at the joints along the whole length of its arm a bright bluish-green light."

Coming to the cœlenterates, we find many notable phosphorescent organisms. The ctenophores and medusæ comprise the greater part of the free swimming members of this subkingdom, and it is among these that we encounter amazing displays of the living light. The most brilliant exhibition of phosphorescence that I have seen was caused by immense numbers of ctenophores in Bahia Honda, Cuba. The animals kept in a compact body, producing a maze of intertwining circles of vivid light. The phosphorescence may help to keep them together, and thus serve the purpose of directive coloration among vertebrates and insects. This same explanation may apply to many of the phosphorescent medusæ. In the subtropical Atlantic hundreds of square miles of the surface are thickly strewn with a medusa, *Linerges mercurius*, which glows like a living coal at night.

In general, it may be said that phosphorescence is found abundantly in free swimming marine animals, and serves the same purpose as protective, aggressive and alluring coloration, and at the same time, in many cases, aids in securing prey by illuminating its retreat.

We come, now, to a consideration of the phosphorescence of the fixed animals of the deep sea and its uses. Most of the light-emitting organisms of this group belong to the subkingdom cœlenterata. The seapens are mentioned by several writers as being especially brilliant in their flashes of light. The gorgonians, or flexible corals, are often phosphorescent, and Agassiz says: "Species living beyond 100 fathoms may dwell in total darkness and be illuminated at times merely by the movements of abyssal fishes through the forests of phosphorescent alcyonarians."

Many authors have noted the light-emitting powers of numerous hydroids. These occur in great quantities over certain areas of the sea bottom, and must add considerably to the sum total of deep-sea light.

It may, I think, be said that in general the fixed marine forms are not behind their free swimming allies in either the equality or the quantity of their light-emitting powers. The question now arises, of what value is the phosphorescence of fixed forms to its possessors? They have no eyes, and therefore can not be guided to their food by the light, neither can it aid them in finding mates nor in revealing the presence of enemies. Perhaps the most generally accepted explanation is that given by Professor Verrill, who says that the phosphorescence protects its possessors. Most cœlenterates, he says, are possessed of nematocysts or nettling cells, and the phosphorescence may serve to give notice to predaceous fishes that feed largely on hydroids, etc., that these nettling cells are present, and thus induce them to seek other provender. It is somewhat unfortunate for this argument that few if any of the cœlenterates that are remarkable for their phosphorescence possess nettling cells that are likely to be regarded by a hungry fish as at all formidable.

Another explanation is, however, possible. The food of the cœlenterates consists mainly of either crustacea of the smaller sorts, their embryos, protozoans, or unicellular plants. Now most of the crustacea have functional eyes, and it has been repeatedly demonstrated that they are attracted by light, both artificial and natural. Crustacean embryos usually have eyes that are proportionally very large. In many cases these too are attracted by light, and it is reasonable to suppose that they are attracted by phosphorescent light. If this is true, the light emitted by the fixed cœlenterates would cause the small crustaceans, and more surely their embryos, to congregate near the illuminated areas and thus be captured. The process would be analogous, perhaps, to what is known as the effect of alluring coloration among insects and birds. The phosphorescence would thus be of direct utility to the fixed cœlenterates in securing food.

The application of this idea may be still further extended to include the attraction of protozoa and even diatoms, both of which groups contain many species that are strongly attracted by light, which appears to act as a direct stimulus to both unicellular animals and plants by virtue of its well-known effect upon protoplasm itself.

One other fact, bearing directly on our discussion, that impresses itself strongly upon everyone who has had actual experience in deep-water dredging, is the very uneven distribution of life over the sea bottom. In other words, the distribution is "spotted." A haul over certain areas will result in a dredge full of a profusion of animal forms, while the immediately adjacent bottom, although of apparently identical nature, will yield practically nothing. Our party repeatedly observed this while dredging on the Pourtales Plateau. It seemed as if species were distributed in densely crowded colonies of very limited areas. Sometimes one particular species seems to have fairly carpeted the bottom, and in other localities a great assemblage of species would be secured at a single haul, showing a profusion of life, perhaps greater than can be found on a similar area either in shallow water or on land. Again the tangles would come up with nothing but sand and bottom debris.

It seems, then, that we are justified in concluding that the sea bottom is, for the most part, utterly dark, but that there are scattered areas, often of considerable extent, where animal life is aggregated in masses, and where the phosphorescent light is of sufficient quantity to render the colors, laid on as we have seen in broad patterns, visible to animals with functional eyes. These colors would then be of the same utility to their possessors as in the upper world, and act as protective, aggressive, directive, attractive and alluring agencies. We are further justified in maintaining that phosphorescence is in all cases of direct utility to its possessors, and that in the fixed eyeless forms it serves to attract food, and perhaps in some cases to warn enemies of the presence of the irritating nettling cells.

As a sort of compensation for the feebleness of the phosphorescent light, and for its absence over vast areas, many animals, and especially fishes and crustaceans, are furnished with very large eyes, or with organs which serve as lanterns, or with enormous mouths and stomachs to make the most of a very occasional square meal, or with greatly elongated feelers or tactile organs. Others still are provided with a luminous bait to attract the prey.

The main thing that I would impress upon you this evening is the fact that we have a right to expect to find utility for every character, not rudimentary, possessed by animals, a utility not necessarily to the individual, but certainly to the species. And I would protest most vigorously against the vain and impotent conclusion that anything is useless simply because we have been too ignorant or too indolent to find its function. I have small patience with a statement such as the following taken from a recent writer on animal coloration: "The inevitable conclusion, therefore, from these facts appears to be that the brilliant and varied colorations of deep sea animals are totally devoid of meaning; they cannot be of advantage for protective purposes or as warning colors, for the simple and sufficient reason that they are invisible."

This sort of thing is deeply injurious to science, because it is a helpless surrender of one of the most powerful of all incentives to research. If we can loll back in our easy chairs and declare that natural phenomena of widespread occurrence are meaningless, or, what amounts to the same thing, that Nature is guilty of a lot of vapid nonsense, we have indeed sold our scientific birthright for a mess of exceedingly thin pottage, and have stultified ourselves in the eyes of the thinking world.*

Hygienic Exposition at Carlsbad.—Consul-General Guenther, of Frankfort, May 11, 1901, reports that a general exhibition of articles of hygiene, of the sick room, of food and drink, and also of those pertaining to the entertainment and comfort of the traveling public, will be opened at Carlsbad on August 10. This will be the first exhibition of the kind at Carlsbad, and from all reports it will receive every possible aid from the authorities and the people of that city.

* Most of the facts and sometimes whole paragraphs concerning the coloration of deep sea animals and phosphorescence, have been taken from the following papers by the author; "The Color of Deep Sea Animals," Proc. Iowa Acad. of Sci., Vol. VI.; "The Utility of Phosphorescence in Deep Sea Animals," Am. Nat., October, 1899.

BETWEEN DAYS ON THE SUEZ CANAL.

OFF SOKOTRA, May 10.—In 1869 the Suez Canal was opened to the world, a supposable photograph of the attendant ceremonies being still on sale at Port Said, wherein the figure of M. de Lesseps stands conspicuous in the foreground. Since that auspicious day the maritime history of the world has been revolutionized, 95 per cent of all steamers trading between Europe and the East now using this great waterway. A rough estimate gives no less than half a million as the average number of persons passing through yearly. The twelve months ending in April of last year recorded 3,605 steamers as traversing the canal, aggregating more than eight million tons. Comparatively few are American; of three hundred in January last, but two sailed under the Stars and Stripes. These were the "Buffalo," from Gibraltar to Manila, and the "Alexander," from Manila to Norfolk, both carrying war material. The largest steamer of her class to go through was the North German Lloyd "Grosser Kurfürst," in November. Of 13,000 tons burden, her English cabin passengers alone numbered three hundred. In addition to those steamers actually traversing the canal, over five hundred last year landed cargo or passengers at Port Said, while two or three times a week boats leave there for the Levant, Jaffa, and Beirut.

This half-way house between East and West, with its forty thousand or more inhabitants, can hardly be longer considered the international dumping-ground of refuse villany; nor can it continue to claim the proud distinction of being the wickedest town of two hemispheres. From the Mediterranean approach, after sighting the spidery lighthouse at Damietta, little is apparent except another tall column and the felucca-rigged dhows of the Arabs. The shores are so extremely low that buildings in the town first come into view, then the statue of M. de Lesseps, and the fine breakwaters, inside which a fleet of steamers of all nations may be seen, generally engaged in the very disenchanting operation of coaling. Port Said is of necessity visited by all voyagers—everybody goes ashore, if for no other reason than to escape the blackening ordeal of his ship. It cannot be said that the town offers anything very attractive in itself; a fine beach, a boulevard along the water, a main street which suggests a toy bazaar, and a seven-story building of brick and iron being all that the casual traveler notices. This "Eastern Exchange Hotel and Club-house," however, is the first really fine edifice erected here, except the handsome and far more picturesque headquarters of the canal company, surrounded by lawns and flower-beds. The hotel is the only one under English management, and here one may find late newspapers and view an endless number of manufacturers' samples and framed cards. The building cost nearly half a million dollars, and was the first hotel in Egypt lighted with electricity. The streets, wide, dusty, unpaved, are filled with a motley company. Egyptians, men and women draped in somber black, brown Arabs, ebony Sudanese, mingle with Europeans of every color and clime, while English, French, and Arabic are heard equally.

Rates of toll for the canal may be altered, but only after three months' notice in the capitals and principal ports of all nations most concerned. These are never to exceed ten francs a ton of capacity, or for each passenger, and have already been twice reduced. Despite that fact, the steamer carrying the Amherst Eclipse Expedition to Singapore paid 800 pounds in dues, even with this expenditure saving more than two-thirds the cost of going around the Cape, to say nothing of time. The rules governing passing craft appear to be strict. Written information as to his ship must be handed in by each captain—her name, nationality, and draft, the port of sailing and destination, as well as his own name and that of owners and charterers and the number of passengers and crew. Naturally, nothing must be thrown overboard, especially ashes and cinders; but also nothing is to be picked up, notice of any article lost overboard being left at the nearest station. No guns shall be fired, and no steam whistles blown except in cases of extreme danger. We are rather grewsomely reminded that burial in the canal banks is strictly forbidden. All sailing vessels above fifty tons must be towed; above one hundred tons must also take a pilot, and no sailing craft may navigate at night. While pilots are compulsory, the entire responsibility still rests with the captain. If local pilots know the canal better than a stranger, it is argued that the captains appreciate more thoroughly the peculiarities and steering capabilities of their own ships. Pilotage dues are only $5; but, at night, rates are doubled. If a collision appears unavoidable, all ships are instructed to run aground to avoid it, the sandy and yielding nature of shallows near the banks offering the less of two evils. But no other ship is permitted to help off a grounded one. Each vessel, on arrival at either end of the canal, must be entered at the Transit Office, and is then supplied with an extra rudder, for more instantaneous control, and at night each must also carry, on its bow, an arc light of sufficient power to show the channel for 1,200 meters ahead, and, when "split," to be capable of illuminating around the vessel an area not less than 200 meters in diameter.

All preliminaries being duly adjusted, we started through as a brilliant Egyptian sunset was burning in the west, and a crescent moon looked down through skies of wonderful clearness upon the varied scene. Any town with lights and water may be beautiful at night, and, as we slowly moved away from the anchorage, even Port Said rose to dignity and loveliness, its lamps reflecting long, wavering lines in the still harbor. Eighty-seven miles lay before us, at a speed not to exceed five and a half knots. Sixty-six are actual canal, while twenty-one miles of the navigation run through Lake Timsah and the Great and Little Bitter Lakes. The fact of the route passing naturally through these small bodies of water did not, to any great degree, lessen the labor of dredging. Only in Great Bitter Lake was there sufficient depth for ocean steamers without artificial excavation, and that for a distance of but eight miles. Here steamers are allowed to use their normal speed and may pass without stopping.

On its surface the canal is generally 320 feet wide; in three places, where the banks are high, aggregating eighteen miles altogether, it is reduced to 195 feet. Its floor measures 72 feet, and the company engage to keep this width dredged to a depth of 26 feet. While the soil is criefly of sand, there is a little rock, soft lime or sandstone near el-Gisr, sandstone also being encountered beyond Tusun. At Serapeum a few yards of hard gypsum were found.

A fine plan for giving safety to all ships in transit is in operation, much resembling the well-known "block system." The company control the departure and entrance of all ships, the order of precedence being wholly in their hands, by which not only security, but the speed of mails, is insured. No ship may demand immediate passage for any reason, but preference is given to regular mail steamers under government control. These carry a blue signal, with P cut out in blank, and a white light at night. The canal is blocked out in divisions, and at the head office in Ismaïlia a dummy model shows the exact moving position of everything afloat. No vessel may proceed until the way is clear, and a complete system of telegraphic signals insures this condition. Along the banks are small stations, twelve between Port Said and Suez, each furnished with a high masthead, from which red and yellow balls by day and colored lights by night announce to each vessel whether to proceed through the next division or to "tie up" and wait for one to go by from the opposite direction. Ships going in the same direction are not allowed to pass one another. Every five or six miles there is a short widening, called locally a "gare," where vessels make fast. The expression "to gare" is also used.

For a short distance from Port Said the Egyptian side shows a narrow plantation of palms and low-growing shrubs, from the depths of which young frogs make insistent music, a cricket or two adding shrill soprano. Beyond the shrubbery, the high moon lighted the shallow Lake Mensaleh into a wondrous sheet of silver, growing wider until no land could be discerned on its farther side. After nine miles it retreats from the canal, leaving a level desert. The eastern bank as well is a low, sandy plain from which evaporating shallow ponds have left a white sediment of crusted salt all over the verdureless country. As far as el-Kantara the low land continues. With a "high Nile" the west side is often overflowed, by which the canal banks are really benefited; the mud deposit, thick and black, strengthening them so that no openings have been forced. At el-Kantara the road comes in from Cairo to Jerusalem, less in use now than before steamers went to Jaffa.

Despite the level country on either side, the evening was full of beauty and interest. The marvelous African firmament seemed to disclose more stars than one knew before; a gentle wave followed our slow progress, to break in miniature surf now and then on the sandy banks, and our brilliant arc light, sometimes turned from side to side, cast a theatrical gleam ahead. On the eastern bank distances are marked in miles, on the western in kilometers; and buoys, white on the east, red on the west, mark the deep-water channel. Buoy lamps in the lakes are kept alight day and night, supplied automatically with oil for three months. Before proceeding very far, signals (two red lights above a yellow) informed us that it was our turn to wait the passing of some steamer from Suez. Immediately our speed was slackened, all movement ceasing as we approached the mooring posts. A small boat must always be in readiness for use with each steamer, and, manned by two or three agile Arabs, a dark object shot out from our side, while shadowy forms jumped ashore, making fast, by bow and stern hawsers, to the deeply embedded bollards on the western bank. At once all our lights were extinguished, the signal that we were fast, and the approaching steamer drew near with much majesty, her searchlight shedding a brilliant glory forward as she silently glided on. Her passengers could make little of us, I fancy, as, according to strict regulations, no lights must be shown by the waiting craft; but the passing steamer, a French mail, was herself gay with lights and people, a pretty spectacle, near and picturesque. Another followed while we still lay quiet. The welcome signal to proceed, a red light above a yellow, finally flashed forth for us from the station, the Arabs deftly uncoiled hawsers, cast off, and, jumping into their little boat, were alongside and aboard in an instant, our lights once more awoke, and we proceeded on our quiet way.

Ismaïlia was reached early in the morning, little but its forest of dhow masts appearing. Near the bank a whole native family seemed to be keeping house in a small rowboat. A man, two women, and a child, evidently recently aroused from their slumbers, had lighted a fire in their tiny craft, over which their breakfast was cheerfully cooking. The pink of sunrise was still flushing the sky, and a Moslem here and there prostrated himself toward the east. In pale-green perspective the narrow waterway lay between its yellow desert banks, lost astern in early-morning haze, but leading forward into a mysterious, shimmering landscape of sunny sand, where faint pictures, drawn in vaporous tints, suggested distant mountains bare and rugged, but softened to mirage effects by the luminous lambent atmosphere. On we crept, along our silent, stealthy way, while steamers now and then "tied up" for us, dredgers on their huge, unwieldly machines glanced up uncuriously, and occasional stations, with small irrigated gardens and wide verandas, shaded by palms and brilliantly blossoming trees, made oases of coolness and comfort in that dry land of perpetual sunshine. Farther out on the desert were occasional ruins; and a tiny train made noiseless if deliberate progress toward Suez.

No perceptible tide or current vexes the Bitter Lakes, the height of their water remaining unvaried. During the winter a current runs northward in the canal, between the lakes and Port Said, and opposite in summer, which perhaps depends on changes of height in the Mediterranean. Little evidence has been found to show that the rising of the Nile affects this current in the maritime canal, although its fluctuations coincide in seasons. But there is communication with Mensaleh Lake, for, when this is filled by the Nile, the water of the canal also becomes fresher as far as el-Kantara, the connection taking the form of fresh-water springs at the canal bottom, which sometimes make upheavals of two or three feet. In April, when Mensaleh is low, the canal, as indeed is the case always with the Bitter Lakes, becomes much salter than ordinary sea water.

Emerging from the canal and rounding a point where the line of dry trees at Port Tewfik tells pitiful tales of heat and drought, anchor was cast in the beautiful bay. Along the curve of the shore lay white Suez, aglow in noonday sunshine, a long line of green palms at one side. Armies of white gulls sailed serenely through the still, warm air, occasionally descending *en masse* to the pale-green water, there to float serenely in a little fleet, rising and falling on the gentle waves. Back of both towns, and far to the east, the yellow desert lay blindingly asleep in the sun, stretches of endless sand, great, masterful, mysterious, the palms at "Moses' well" rising in shadowy plumes against distant Arabian mountains. West of Suez the gleaming sand crept upward from the plains of Mohaggiara around the bases of the majestic Ataka range, suddenly giving place to their stupendous rock cliffs and precipices. Not one green or growing thing softens their harsh boldness, but the atmosphere takes them in hand, painting elusive tints on foreground and further distance, spreading a pearly opalescence with suggestions of red flame at the heart of things, finally melting away into the far line of open sea horizon.

From the Straits of Jubal, at the southern end of the Gulf of Suez, Mount Sinai and Mount Horeb may be seen, conspicuous peaks in the chain Jebel Musâ. Through the Red Sea, that hot highway of nations, from which the keels and commerce of the world are never absent; past the port of Mecca, where twenty thousand and more pilgrims land yearly in their devout journey; past Mocha and its traditions of coffee, and Zurkur, largest island of the sea; through the famous Straits of Bab-el-Mandeb, leaving Aden shimmering in dry heat, and Cape Guardaqui looming astern, we are to-day skirting Sokotra, that strange island under British control, about which so little is known. Fine aloes grow wild, four thousand or more Arabs inhabit its valleys, and, despite several wrecks on its eastern point, no lighthouse warns of its proximity—dangerous during the southwest monsoon. In 1896 Mr. Theodore Bent induced a steamer bound for Bombay to land him there as a favor, with Mrs. Bent and a friend, and he spent some months exploring and hunting. An article descriptive of those experiences, and of the flora and fauna, the natives and mountain-peaks, is perhaps the only one ever written of an island passed yearly by countless steamers. The method of return to more frequented regions was problematic, but ultimately he reached Aden in the dhow of the local Sultan, at an exorbitant rate of passage, that potentate having ordered all other dhows to refuse him transit that there might be no competition with royalty.

And now the placid Indian Ocean, with its gentle remnant of northeast monsoon, its exquisite climate, and enchanting moonlight nights, beckons us onward to the Far Orient.—Mabel Loomis Todd in Evening Post.

INJURY OF COAL BY EXPOSURE TO THE WEATHER.

COAL exposed to the open air loses its heating power slowly. This loss, according to an editorial on the subject in The Engineer, is due to a slow combustion or union of the coal with the oxygen of the air, which differs from ordinary combustion only by its slowness and the small part of the coal which is liable to combustion under such circumstances. The author goes on to say: "Owing to the slowness of the operation the heat generated has an opportunity of escaping, and thus there is no marked rise of temperature. If, however, the heat thus generated is prevented from escaping, it may become banked up, so to speak, in the coal pile, and a rise of temperature may follow which will tend to accelerate the combustion, and thus these two conditions will progress, each tending to increase the other until finally active combustion bursts out, and *spontaneous combustion* is said to result. In general, however, danger of spontaneous combustion is not likely to arise under the conditions affecting the stationary engineer, and he is chiefly concerned with this slow combustion as an influence which may affect the quality of his coal. . . . The chief external conditions which may affect weathering are *moisture* and *temperature*. With a coal free from iron pyrites the presence of moisture is believed to slightly retard the operation of slow combustion, and thus to exercise a beneficial influence. On the other hand, with a coal rich in iron pyrites the conditions are reversed. This substance readily oxidizes at ordinary temperature, the operation being aided by moisture. As a result of the operation, heat is developed and the pyrites is destroyed, in consequence of which the lump of coal tends to break up into small bits, thus exposing fresh surfaces to the air."

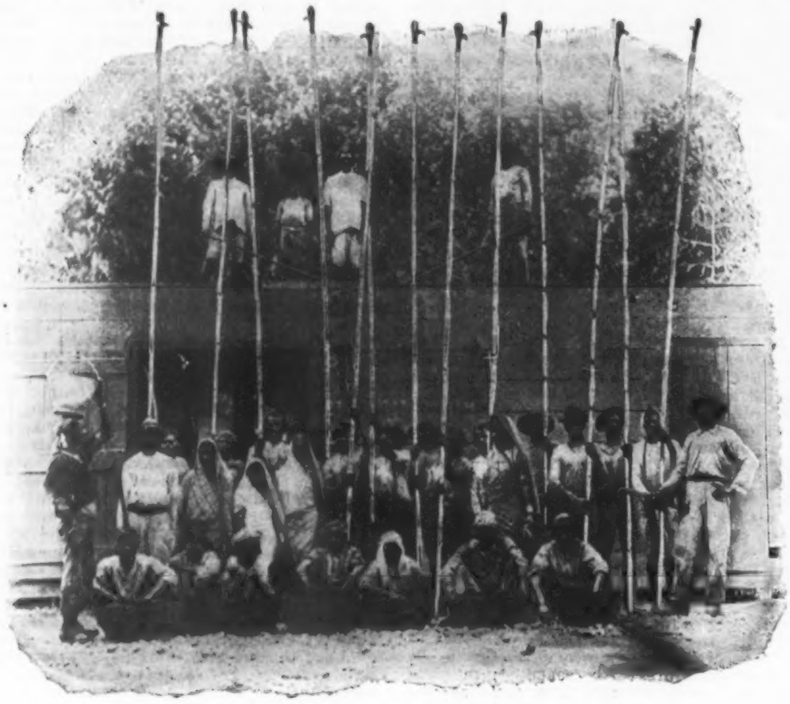
British Complaints of American Iron.—Consul Marshal Halstead writes from Birmingham, May 17, 1901, that complaints of the quality of American iron have appeared in a local paper. It is stated that it is not available for purposes requiring great tensile strength and uniformity of quality. Whether these charges are true or not, says the consul, American merchants and manufacturers can understand why, with such statements current, there is a decided disinclination abroad to pay for shipments f. o. b. New York or any other American point.

New River Steamer at Frontera.—Consul Canada reports from Vera Cruz, May 7, 1901:

On May 5, a new steamer was placed in service in the port of Frontera, to be employed in transporting passengers and freight between points along the extensive river system of the State of Tabasco. It was constructed at Frontera, all foreign material used in her construction being brought from the United States. It is equipped with all modern conveniences, including a good search light, and will make speed of 12 miles an hour.

COCOA AND CHOCOLATE.

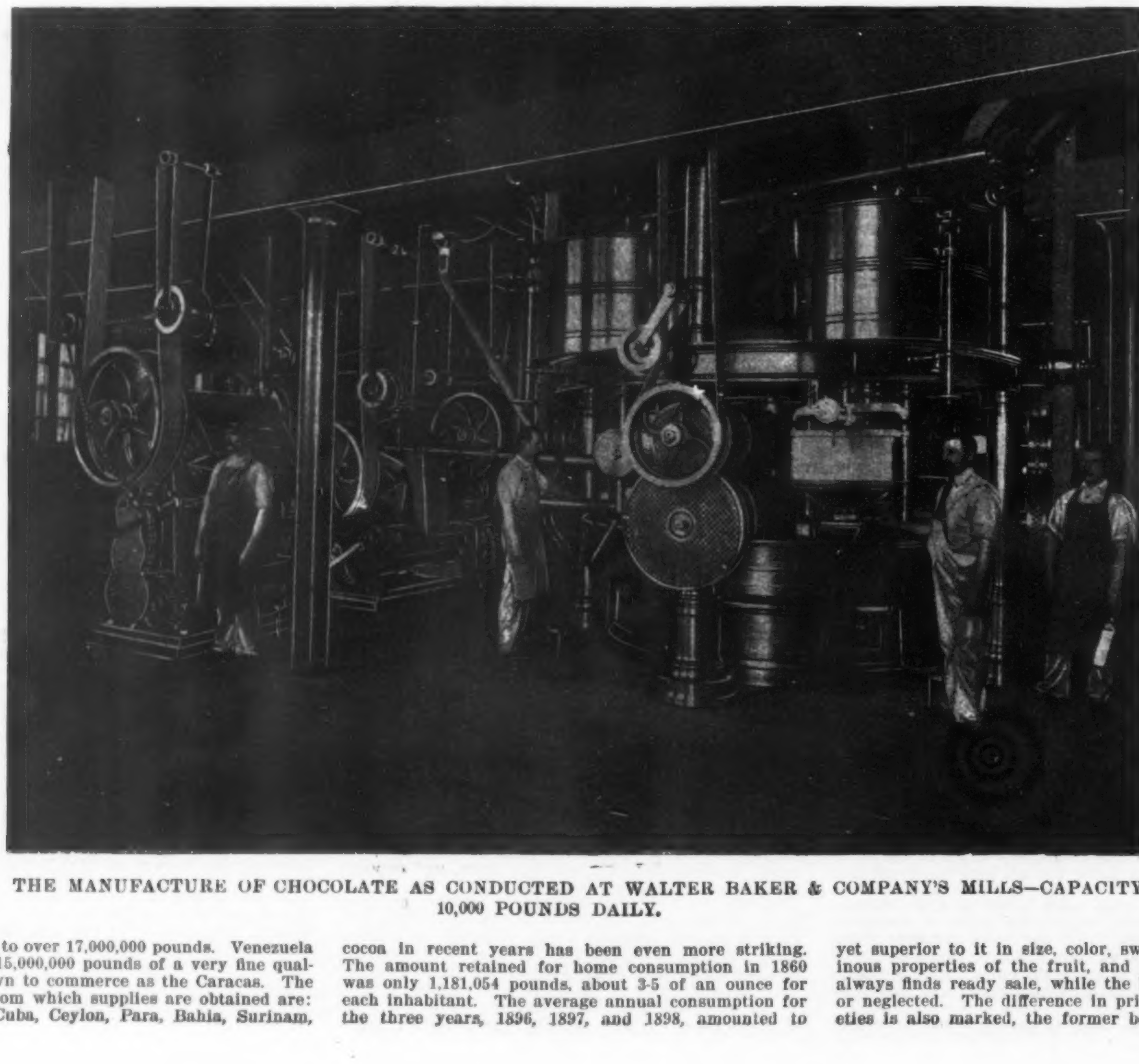
THERE has been a remarkable increase in the consumption of cocoa and chocolate in recent years; and it is a significant fact that the increase is found mainly among the people whose hands and brains are to-day doing the most work in the world. During the last twenty years the cocoa crop has about doubled, and



GROUP OF NATIVE COCOA PICKERS.

much the larger part of that increase has been consumed in the United States, Great Britain, and Germany—countries in which the greatest progress is being made in the science of nutrition, and in the inventions which have done so much to cheapen the cost and improve the quality of articles of food.

A recent estimate of the total amount of crude cocoa exported from the tropical regions in which it is grown, based partly on official figures and partly on expert estimates, is about 150,000,000 pounds per annum. Guayaquil, Ecuador, heads the list of exports with about 33,500,000 pounds. The British island of Trinidad comes next, with about 22,000,000. The African crop has been greatly developed within a few years,



THE MANUFACTURE OF CHOCOLATE AS CONDUCTED AT WALTER BAKER & COMPANY'S MILLS—CAPACITY 10,000 POUNDS DAILY.

and now amounts to over 17,000,000 pounds. Venezuela furnishes nearly 15,000,000 pounds of a very fine quality of cocoa, known to commerce as the Caracas. The other countries from which supplies are obtained are: Grenada, Hayti, Cuba, Ceylon, Para, Bahia, Surinam, Martinique, Guadeloupe, Java, Dominica, St. Lucia, and Jamaica.

Humboldt estimated the consumption of cocoa in Europe, in 1806, at 23,000,000 pounds per annum, of which from 6,000,000 to 9,000,000 were supposed to be consumed in Spain. The estimated consumption at the present time is over 100,000,000 pounds.

In Great Britain the amount consumed in 1831 was only ¼ of an ounce for each inhabitant. In 1897 it had risen to 14 ounces—that is, about 36,000,000 pounds. The percentage of increase since 1860 has been much greater than that of tea and coffee. In that year the consumption of tea was 2½ pounds for each inhabitant; of coffee, 1 1-5 pounds; of cocoa, 2 ounces. In 1897 the consumption of tea was 5 pounds for each inhabitant; of coffee, only 12 ounces; of cocoa, 14 ounces. It appears from this that in Great Britain cocoa is actually taking the place of coffee, the per capita use of the former having increased about 600 per cent, while the per capita use of the latter has decreased about 365 per cent.

In the United States the increased consumption of cocoa in recent years has been even more striking. The amount retained for home consumption in 1860 was only 1,181,054 pounds, about 3-5 of an ounce for each inhabitant. The average annual consumption for the three years, 1896, 1897, and 1898, amounted to 26,319,275 pounds, an increase in thirty-seven years of 2,130 per cent. This percentage of increase is considerably larger than the increase during the same period in the consumption of coffee, although the latter has reached the enormous amount of nearly 10 pounds for each inhabitant, while only 6 ounces of cocoa and 2½ pounds of tea are used.

If the increased consumption of the last thirty-seven years is continued until 1934—and that is altogether probable, in view of the fact that cocoa is one of the very few articles which contain all the essentials of a perfect food—the amount of crude cocoa required by this country alone will be nearly 600,000,000 pounds. The islands over which the sovereignty, or protection, of the United States has recently been extended are all within the cocoa belt (i.e., within the parallels of latitude in which cocoa can be successfully cultivated), and we may look for an enormous development of the production during the next quarter of a century.

The term "cocoa" is a corruption of "cacao," but is almost universally used in English-speaking countries. The cacao tree belongs to the natural order of Sterculiaceæ—a family of about 41 genera and 521 species, inhabiting the warmer regions of the world. None of them grow naturally in our climate or in Europe, and, excepting the little yellow-flowered Mahernia, they are very seldom seen in our conservatories.

The first references to the tree and its products are found in the accounts of the explorers and conquerors who followed Columbus. Their descriptions are remarkably accurate in all essential particulars. One of the earliest, if not indeed the very earliest, delineations of the tree is in a rare volume by Bontekoe.

The seeds of the tree are borne in pods, which are irregular and angular in shape, much like some forms of cucumbers, but more pointed at the lower extremity, and more distinctly grooved. These pods measure in length nine inches to a foot, or even more, and about half as much in diameter. The color, when young, is green, becoming later dark yellow or yellowish brown. The rind is thick and tough. The pods are filled with closely packed "beans," or seeds, embedded in a mass of cellular tissue, sometimes of pleasant subacid taste. The seeds are about as large as ordinary almonds, whitish when fresh, and of a disagreeable bitter taste. When dried they become brown.

The fruits are about four months in ripening, but they appear and mature the whole year through. In point of fact, however, there are chief harvests, usually in early spring, but this is different for different countries.

The following extract from a report made by the American Consul at La Guayra about ten years ago gives a clear idea of the modern method of cultivating the tree in some parts of South America.

"The tree grows to the average height of 13 feet, and from 5 to 8 inches in diameter, is of spreading habit and healthy growth, and although requiring much more care and attention than the coffee tree, yet its equally reliable crops require comparatively little labor in properly preparing for the market.

" . . . There are two varieties of the cocoa tree cultivated in Venezuela, known as El Criollo and El Trinitario, respectively, the former of which, though not so prolific, nor as early fruiting as the latter, is yet superior to it in size, color, sweetness, and oleaginous properties of the fruit, and in the fact that it always finds ready sale, while the latter is often dull or neglected. The difference in price of the two varieties is also marked, the former being quoted at $28

to $30 per fanega (110 pounds), while the latter commands approximately half that price.

"While coffee can be successfully cultivated under a temperature of 60 deg. F., the cocoa tree, for proper development and remunerative crops, requires a temperature of 80 deg. F.; hence the area of the cocoa belt is comparatively restricted, and the cocoa planter presumably has not to fear the fierce competition that he

A MOLDING ROOM.

has encountered in the cultivation of cotton and coffee. Besides the condition of temperature above stated, this crop needs a moist soil and humid atmosphere; and so the lands along the coast of the Caribbean Sea, sloping from the mountain tops to the shore, bedewed by the exhalations of the sea and irrigated by the numerous rivulets that course down the valleys, are found to be, in all respects, well adapted to the

PODS AND LEAVES.

profitable cultivation of cocoa. And while the lands in the interior possessing facilities for irrigation may be said to be equally as good for the purpose, yet the absence of roads, and the consequently difficult transportation of produce on the backs of donkeys over rugged mountain paths, materially reduce the profits on the crop before it reaches the market.

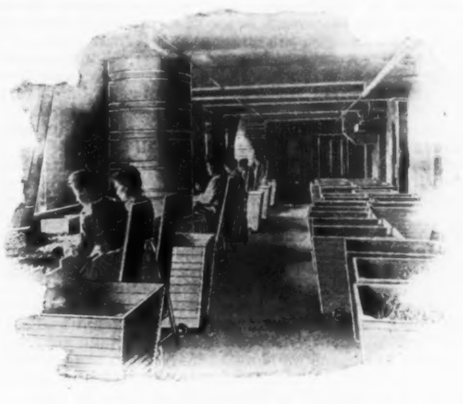
"A cocoa plantation is set in quite the same manner as an apple orchard, except that the young stalks may be transplanted from the nursery after two months' growth. No preparation of the soil is deemed necessary, and no manures are applied. The young trees are planted about fifteen feet equidistant, which will accommodate two hundred trees to the acre. Between rows, and at like spaces, are planted rows of the Bucare, a tree of rapid growth, that serves to shade the soil as well as to shield the young trees from the torrid sun. Small permanent trenches must be maintained from tree to tree throughout the entire length of the rows, so that, at least once in the week, the stream descending from the mountains may be turned into these little channels and bear needful moisture to trees and soil. At the age of five years the plantation begins to bear fruit, and annually yields two crops, that ripening in June being termed the crop of San Juan, and that maturing at Christmas being known as the crop of La Navidad. The average age to which the trees attain, under proper care, may be estimated at forty years, during which period they will give fair to full crops of fruit; but of course it must be understood that, as in our fruit orchards, a new tree must be set from time to time to replace one that may be decayed or blighted. After careful inquiry, it may be safely stated that the average crop of the cocoa plantation, at ten years of age, and under a proper state of cultivation, will amount to 500 or 600 pounds per acre."

The method of preparing the fruit for shipment is thus described in the Encyclopædia Britannica:

"In gathering, the workman is careful to cut down only fully ripened pods, which he adroitly accomplishes with a long pole armed with two prongs or a knife at its extremity. The pods are left in a heap on the ground for about twenty-four hours; they are then cut open and the seeds are taken out and carried in baskets to the place where they undergo the operation of sweating and curing. There the acid juice which accompanies the seeds is first drained off, after which they are placed in a sweating-box, in which they are inclosed and allowed to ferment for some time, great care being taken to keep the temperature from rising too high. The fermenting process is, in some cases, affected by throwing the seeds into holes or trenches in the ground, and covering them with earth or clay. The seeds in this process, which is called 'claying,' are occasionally stirred to keep the fermentation from proceeding too violently. The sweating is a process which requires the very greatest attention and experience, as on it, to a great extent, depends the flavor of the seeds and their fitness for preservation. . . . Thereafter the seeds are exposed to the sun for drying, and those of a fine quality should then assume a warm, reddish tint, which characterizes beans of a superior quality."

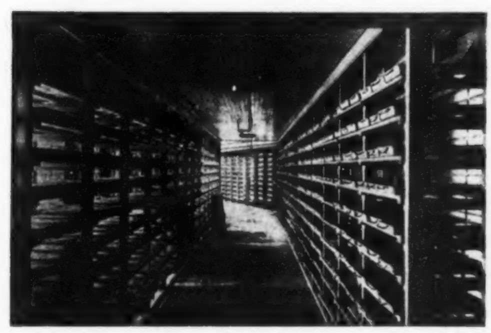
The seeds are brought into the market in their crude state, as almond-shaped "beans," which differ in color and somewhat in texture. It is not uncommon to find the external surface more or less covered with a thin, irregular layer of attached earth, but this is almost wholly rubbed off during transportation. Upon the color of shell and kernel, the relative brittleness, the flavor, and the odor depend the market value of the seeds.

The dried seeds have a papery, brittle shell, which



FINAL PROCESS OF SELECTION.

is very smooth on the inside, but which on the outside exhibits, under the microscope, a few short hairs and round excrescences. But these are mostly lost by the rough handling and by the attrition of the seeds with one another during transportation. The kernel consists of two large cotyledons or seed-leaves, reddish gray or reddish brown, with a shining, oily surface, the whole crushing rather easily into a loose mass of fragments. The kernel, when dry, has a minute, tough, almost stony radicle, which separates easily from the cotyledons. Microscopic examination shows that the cells of the seed-leaves contain albumen, oily matters—sometimes in a crystalline condition—crystals of an entirely different shape, starch, coloring substances in special receptacles known as pigment cells,



COOLING ROOM.

and ducts with spiral markings. The starch grains do not have any very characteristic form or markings; they are generally spherical and simple. The only peculiarity worth mentioning is the relative slowness with which they are acted upon by hot water and by iodine. The coloring substances are mainly of a carmine or violet color, and are distinguished by the change of shade when an alkali is added, becoming thereby darker.

These are the only structural elements which a pure powder or paste of chocolate should show under the microscope. Any other substances must be recognized as accidental or intentional additions.

All seeds of whatever kind contain, as a part of their substance, the matter of which cell walls are made, namely, cellulose. The percentage differs in different seeds, in those of the chocolate plant being about three in the hundred. Cellulose has the same chemical composition as starch, but its physical properties are not the same as those of starch. Among these may be

THE GRINDING ROOM.

ASSORTING BEANS.

mentioned its entire insolubility in boiling water, whereas starch readily dissolves.

Starch forms, on an average, 8 to 10 per cent of chocolate seeds. It consists of minute spherical grains, not distinguishable from those found in many other kinds of seeds. Traces of gum and of other allied bodies are also present in the seeds.

Albuminoids, or substances resembling in a general way the albumen of egg, occur in chocolate seeds as they do in other seeds, and in a somewhat higher amount than in certain other cases in which seeds are used as food. The percentage ranges from about 15 to 20, depending on the variety. These albuminoids are compounds of nitrogen, and are extremely nutritious. In the seeds they occur in a readily assimilable form, fit for digestion.

Cacao red occurs as a coloring matter in small amount. It is rendered dark by alkalies.

Theobromine, the active principle of the cocoa bean, constitutes less than 1 per cent of the weight of the seeds, but it varies greatly in amount in different seeds, ranging from 30-100 of 1 per cent in some to a trifle over 1 per cent in others.

The ash left, on completely burning cocoa beans, is not far from 4 per cent. Its composition is substantially that of the ash of seeds of other plants.

Cocoa butter, or oil, constitutes not far from 50 per cent of good cocoa beans. The oil is remarkable for its freedom from rancidity and its very bland character. Its uses are innumerable.

The following averages of many analyses by leading authorities may be of interest:

	Unroasted.	Roasted.
Moisture	7.11	6.51
Oil	51.78	49.24
Theobromine	.35	.43
Starch	5.78	10.43
Cellulose	3.1	3.1
Other carbohydrates, glucosides, etc	10.05	7.78
Protein matters	15.61	18.33
Ash	3.60	3.92

The three associated beverages, cacao, tea, and coffee, are known to the French as aromatic drinks. Each of these has its characteristic aroma. The fragrance and flavor are so marked that they cannot be imitated by any artificial products, although numerous attempts have been made in regard to all three. Hence, the detection of adulteration is not a difficult matter. Designing persons, aware of the extreme difficulty of imitating these substances, have undertaken to employ lower grades, and by manipulation copy, as far as may be, the higher sorts. Every one knows how readily tea and coffee, for that matter, will take up odors and flavors from substances placed near them. This is abundantly exemplified in the country grocery or general store, where the teas and coffees share in the pervasive fragrance of the cheese and kerosene. But perhaps it is not so widely understood that some of these very teas and coffees had been artificially flavored or corrected before they reached their destination in this country.

Cacao lends itself very readily to such preliminary treatment. In a first-class article, the beans should be of the highest excellence; they should be carefully grown on the plantation and there prepared with great skill, arriving in the factory in good condition. In the factory, they should simply receive the mechanical treatment requisite to develop their high and attractive natural flavor and fragrance. They should be most carefully shelled after roasting and finely ground without concealed additions. This is the process in all honest manufactories of the cacao products.

Now, as matter of fact, in the preparation of many of the cacao products on the market a wholly different course has been pursued. Beans of poor quality are used, because of their cheapness, and in some instances they are only imperfectly, if at all, shelled before grinding. Chemical treatment is relied on to correct in part the odor and taste of such inferior goods, and artificial flavors, other than the time-honored natural vanilla and the like, are added freely. The detection of such imposition is easy enough to the expert, but is difficult to the novice; therefore the public is largely unable to discriminate between the good and the inferior, and it is perforce compelled to depend almost entirely on the character and reputation of the manufacturer.

The simple process by which the natives of Central and South America prepare a nutritious beverage from the seeds of the cocoa tree has already been described. We will now refer briefly to the modern method of manufacture as carried on in the Walter Baker establishment, in which the latest and most improved machinery and appliances are used to improve the quality and cheapen the cost of production.

The selected cocoa beans are first cleaned from the dust and attached particles which have come from various sources during the fermentation of the seeds. The machines for cleaning the beans are very ingenious and effective, removing from the seed coat every trace of foreign matter.

The cleaned seeds are next roasted in the most careful manner, every precaution being taken to secure a uniform effect through the whole mass. During the roasting the seeds change color somewhat and become more or less modified in taste. In under-roasted seeds the flavor is not fully developed, while in over-roasted seeds the pleasant taste is likely to become greatly impaired, or it may even be wholly replaced by a bitter and harsh flavor. These relations of color and taste to the roasting of the seeds make this portion of the manufacture one of the most delicate processes from beginning to end.

By the roasting the shell becomes more readily detachable, and its complete removal is the next step. The crushing of the seeds into small fragments is easily accomplished; and this is followed by a thorough winnowing, by which the lighter shells are carried away by themselves, leaving the clean fragments of the roasted seeds ready for further manipulation.

Among the fragments can be detected minute and very tough bits of tissue. These bits are the hardened germs, or rather portions of the germs, and these are separated from the rest by an apparatus of much simplicity and efficiency.

The clean shells are usually placed at once in packages for transportation. They are extensively used for the domestic preparation of a wholesome and very low-priced drink. This beverage contains a fair proportion of the active principle of the chocolate seeds themselves, and the flavor is suggestive of chocolate.

The cleaned fragments constitute the so-called "cocoa nibs" of some foreign markets, and in this state they are used for the preparation of a simple decoction. But in this form they require to be boiled a good while for the development of flavor, and it is, therefore, better to have them treated beforehand in order to reduce the time of boiling; and this is all the more necessary, since during the long boiling a part of the more delicate aroma peculiar to chocolate seeds is apt to be dissipated.

In the preparation of chocolate, the fragments are ground by complicated mechanism until they attain the greatest degree of fineness, and constitute a perfectly homogeneous mass or paste. If it is to be a plain chocolate, it goes directly into the molds for shaping it.

The molding is a noisy but interesting operation. The chocolate cannot be pressed into molds, because it sticks to the presser; it is, therefore, shaken in. A plastic lump of the proper weight is placed in a shallow mold. A number of these molds are put into a wooden tray, placed upon a table, which is shaken automatically, causing the metal molds to jump up and down in a very lively manner, and making as much clatter as a regiment of cavalry crossing a bridge. Every step of the process has to be watched with the most assiduous care. When the plastic mass has been shaken into the mold so as to be perfectly uniform in shape and size, the pans are removed to the cooling room.

If the chocolate is to be sweetened, a definite amount of the purest sugar, previously pulverized, is added before the molding, and the whole ground and commingled. If it is to be a vanilla chocolate, the finest quality of Mexican vanilla beans (which are superior to those grown elsewhere) are blended with the semi-fluid mass, and formed in molds, as already described.

The variations in the process are innumerable, many of them comparatively unimportant when taken singly; but to secure the best results it is important that each of these slight changes should be made at just the right time and in the right way.

The manufacture of breakfast cocoa is based upon two important factors: first, the removal of a definite portion of the cocoa-oil from the roasted seeds; and second, increasing the miscibility of the powdered seeds by securing the greatest practicable degree of fineness.

While the oil of the chocolate seed is perfectly wholesome, there are some persons who find in the percentage natural to the seeds an amount too large for easy digestion.

The method of manufacture is substantially as follows: the ground fragments of roasted seeds are subjected to hydraulic pressure, by which a certain amount of the fat is eliminated. The pressed mass is, in the most successful process, treated mechanically in such a manner as to divide and subdivide the minute particles until they are capable of passing through a sieve having several thousand meshes to the square inch. But such pulverization as this would, under ordinary circumstances, reduce the mass to a dull and unattractive powder. In the process devised by the Company, this high degree of fineness is secured without any loss of brilliancy in the powder—the color being of the bright red which is not only attractive in appearance, but when conjoined with the natural chocolate odor and flavor is characteristic of absolutely pure cocoa of the highest grade.

It is instructive to compare such cocoa with the cocoas prepared by what is known as the Dutch process. The latter are prepared by treatment with alkaline matters, which act on the coloring substances in the seeds, increasing the apparent effect of hot water when the latter is added. In chemically prepared cocoas, the exquisite natural odor and flavor of pure cocoa seeds have been diminished or wholly lost by the severe treatment to which the materials have been subjected. In some cases the loss of the natural flavor is sought to be partially supplied by the use of fragrant gums and other matters wholly foreign to the natural product.—For the foregoing particulars and our illustrations we are indebted to "Cocoa and Chocolate," copyrighted 1899 by Walter Baker & Co., Ltd.

THE FIRE HAZARD OF THE MORE IMPORTANT CHEMICAL PRODUCTS.*

By Ernest H. Cook, D.Sc., F.I.C., F.C.S.

It was once said by the late Lord Beaconsfield that the prosperity of a country could be judged with very great accuracy by observing the amount of trade done by it in chemicals.

In attempting to consider the manufacture and storage of chemicals, from a fire insurance point of view, one is confronted with the enormous quantity and variety of the substances included under the head of chemicals. The farmer who crushes his apples and ferments the juice is as much a chemical manufacturer for the time as the maker of caustic soda or the producer of explosives. Anything like a complete consideration of the subject, at any rate in the time at my disposal, is therefore quite out of the question. All that is possible is to consider briefly the purely chemical substances which are manufactured on a large scale.

Then, again, in all large manufactories some source of power is required, and in almost all the materials require heating before the necessary chemical change can be brought about. Although in some works electricity is employed as a means of driving the machinery, practically steam is the source of power employed in all our large industries. When electricity is used there are fire risks of a special kind to be guarded against; some of these are due to the machinery used for generating the electricity, some due to defects in the installation. Both, of course, are of great importance, but the consideration of them is outside my present purpose. And even in the case of steam, the risks attendant upon its production and conveyance (i. e., steam pipes) from one place to another will not be touched upon, except, for example, in such a case as when the proximity of a steam pipe is likely to increase the violence of a chemical change, and hence improve the chances of a fire resulting.

Similarly the risks attendant upon the production of means of heating the materials are not, of themselves, relevant to our present inquiry. But as many chemical substances have their activity enormously increased by rise in temperature, and as the relative positions of the source of heat and the vats or other vessels in which the chemical change is taking place is of importance, it will be necessary at times to touch upon this point.

Yet again, the particular systems employed in most manufacturing operations have been carried out for so many years without any mishap in the nature of a fire, that one is placed in a somewhat embarrassing position in venturing to suggest possible sources of danger. It is most surely true that "familiarity breeds contempt," and the chemical manufacturer will smile incredulously when it is suggested that greater care might be exercised in some particular process. The position he takes up is, either that the matter is altogether too trivial, or the possibility of a fire resulting is so remote as to need no consideration. But in this matter it is always "the unexpected that happens," and when a great fire has occurred, the unvarying story is that the "cause was completely unknown." Moreover, generally speaking, it is not the great and self-evident dangers which produce fires. These are generally well guarded against, but it is the minor causes which are often overlooked.

In this paper, therefore, it will be my duty to lay stress upon many matters which may, at first sight, appear trivial, but which if not looked after may lead to consequences of the greatest importance and to immense destruction of valuable property.

Chemical changes are innumerable and of every degree of vigor. No one can say with certainty beforehand how vigorous a particular change will be. All that any chemist can do is to reason that from the known behavior of certain chemical substances under similar conditions, the substances under treatment will behave in such and such a way. But there is no definiteness about this, and the only way to be sure is to try the experiment. Now, as one result of the centuries of experimenting which have taken place in chemistry, we know that there are various classes of chemical elements and substances. Some of these are distinguished by being very reluctant to enter into change, others are less reluctant, still others are most active, producing changes even with the first class that I have mentioned, and when they interact among themselves the changes are usually rapid and violent. It is obviously changes of this latter class which produce fires.

Such, then, are the general principles involved in our inquiry, and we will now proceed to consider the matter in detail.

In order to do this we must endeavor to classify the various manufactures in some way. This, however, is very difficult; any arrangement must be very incomplete. But even a rough plan will be of advantage, and I have therefore drawn up the following:

1. Metallurgical operations.
2. Alkali works.
3. Benzine and allied bodies.
4. Paints, varnishes, etc.
5. Explosives.
6. Other chemical substances.

By considering these in detail we shall be enabled to deal with most of the important chemical substances manufactured, as well as have a means of reference if desired.

CLASS I.—METALLURGICAL OPERATIONS.

It is perhaps somewhat doubtful if we can strictly regard the products of metallurgical operations—that is, metals—as fairly coming within the category of chemical substances. But if that criticism has any weight when referring to the more common metals—such as iron, copper, lead, etc.—it certainly has none when the less widely used, but still important, metals—such as sodium, magnesium, etc.—are concerned. These may truly be called chemical products, and have an important bearing upon fire risks, if not from their manufacture, most certainly from their storage and carriage.

Taken as a whole, the operations included under the head of metallurgy do not afford a large number of fire risks of what one may call the most interesting kind, i. e., where the causes producing the fire are more or less obscure.

In regard, therefore, to the larger manufactures it will not be necessary to pursue inquiries, but some of the small operations will repay a little attention.

The first substances to mention are sodium and potassium. These two metals were discovered by Sir Humphry Davy and are known to chemists as alkali metals, because they are the essential elements present in the strong alkalies—soda and potash. They are distinguished as possessing remarkably active chemical properties; in fact, they are, undoubtedly, two of the most active chemical elements known. For many years they were simply regarded as chemical curiosities; but later on their strong chemical power was made use of in turning other less active metals out of their combinations, and hence in helping in the manufacture of this latter kind of metal. Both metals are made in the same way—by strongly heating a mixture of the hydrates of potassium or sodium with a compound of iron and carbon known as carbide of iron. The operation is conducted in egg-shaped retorts with removable covers, and the heating is accomplished by regenerative gas furnaces. The distilled metal passes into long, narrow, cast-iron condensers, from which it drops into iron pots containing mineral oil to protect the metal from oxidation. In the case of potassium an explosive compound of the metal and carbon monoxide, which is produced by the chemical change, is liable to form. Special precautions should therefore be taken to guard against this by avoiding an excess of carbon in the carbide. Sodium is not so dangerous. But it is in the storage of these metals that the great danger arises. If exposed to the air they oxidize, i. e., combine with oxygen very readily and, of course, produce heat. But when moisture is present this oxidation goes on with greatly increased vigor; hydrogen is given off, and this hydrogen is generally ignited—always so in the case of potassium, frequently so

* Extracts from a paper read before the Bristol (England) Insurance Institute.—From Insurance Engineering.

in the case of sodium. Consequently, it becomes of the greatest importance to see that these substances should be properly stored in thoroughly dry places, and, preferably, that they should be kept under mineral oil, which is perfectly free from oxygen.

Sodium is employed in the manufacture of magnesium and aluminium, and as an alloy with mercury in treating gold ores for the purpose of dissolving the gold. In the two former cases the sodium is made use of by heating the chlorides of the metals with it. The superior power of the sodium draws away the chlorine from its combination and sets free the metal. Large quantities of sodium are used for this purpose, and its storage and proper handling in such works should be carefully looked after. The manufacture of aluminium is now, however, largely carried on by means of the electric furnace, thus avoiding the use of sodium and cheapening the process.

Before leaving our consideration of the metals it may be as well to point out a general warning, viz., that almost all are liable to combine with oxygen. In ordinary conditions this combination—as, for example, in the case of iron rust—is not accompanied by much heat; but chemical action is always much intensified by causing the bodies to be in a fine state of division, and hence, if we have the metals in a finely-powdered condition, rapid oxidation will go on, frequently resulting in enough heat to cause incandescence.

CLASS 2.—ALKALI WORKS.

This manufacture is certainly the most important of all those usually included under the head of chemical trades. Originally the production of carbonate of sodium was the only object of the alkali-maker; but, gradually, side products were added, until at the present day a very large number of important chemical substances are made side by side with carbonate of sodium, which, although it may still be the product made in the largest quantity, is probably not that which yields the greatest revenue.

The compound of sodium, which occurs in inexhaustible quantity in the earth, is sodium chloride, or ordinary salt; and hence the problem which exercised the minds of the chemists during the last century—immediately after Duhamel had shown in 1736 that the base of salt and that of soda was identical—was how to convert common salt into caustic soda. Numerous plans were tried, but all more or less unsuccessful, until Leblanc, who was physician to the Duke of Orleans, introduced his process somewhere about 1790. This process, with slight modifications, is still the one by which the greater amount of the carbonate of soda used in commerce is manufactured.

It consists essentially of three parts:

1. The conversion of the salt into sodium sulphate, by the action of hot sulphuric acid. This is known as the salt-cake process.
2. The decomposition of the sodium sulphate at a high temperature by means of limestone and coal; known as the black ash process.
3. The process of extracting and purifying the sodium carbonate contained in the black ash.

In the first process strong sulphuric acid is poured on the salt, which is contained in a large iron pan. A moderate amount of heat is applied to start with, and hydrochloric or muriatic acid gas is given off. This passes from the furnace through condensers, consisting of towers filled with coke down which water is trickling. The water dissolves the acid, and the solution is collected at the bottom of the towers, and forms commercial hydrochloric or muriatic acid. Only a part of the salt is decomposed in the iron pan and by a moderate heat. Therefore, when the first ebullition of the acid fumes almost ceases and the mass becomes pasty, it is raked from the pan on to the hearth of the "roaster," where it is heated more strongly; almost to redness. This completes the decomposition, and more hydrochloric acid is evolved. The salt-cake or sulphate of sodium produced is raked out of the furnaces, allowed to cool, and stored in bins until required. Here is a point sometimes requiring attention. There is a tendency to remove the substance from the furnace before it has had time to cool sufficiently, and one has occasionally seen fresh salt-cake lying in the bins so hot as not to be capable of handling. If this should come into contact with woodwork there would be a great probability of charring and, under favorable conditions, of a fire; while if the bin of hot material adjoins or is near to bins of other substances which are used or made in the works—such as niter or chlorate, and which are powerful supporters of combustion—then it is quite possible this hot salt-cake may lead to a very serious conflagration.

It will be observed that sulphuric acid is used in the manufacture; and hence almost every maker of salt-cake is also a maker of sulphuric acid or oil of vitriol. This substance is made in large leaden chambers, where steam, sulphur dioxide, and vapor of nitric acid are made to come together, along with a little air. Chemical reactions ensue, resulting in the formation of a solution of sulphuric acid, which collects on the floor of the leaden chamber and is drawn off from time to time from the outside. The chambers work continuously, but the acid is not allowed to accumulate in them beyond a certain strength. Above this, action on the lead would rapidly take place and the chambers be ruined.

The sulphur dioxide required in the manufacture is obtained by roasting iron pyrites—a yellow mineral containing a large percentage of sulphur. This substance occurs in small quantities in coal, where it is known as "brass"; and in many cases the heat caused by the oxidation of the sulphur in presence of oxygen and moisture has given rise to the spontaneous ignition of the coal. When in bulk, as in the manufacture of sulphuric acid, the tendency to oxidize is not so great, because the material is not in a finely divided state, and hence its liability to cause injury is not so great. Care should, however, be again taken with the roasted material from which all the sulphur has been burnt off. This is frequently withdrawn from the ovens before it is cold, and the same danger attends this as does the storage of the fresh salt-cake. No woodwork should be near, and certainly no stores containing niter or chlorate.

The nitric acid required for the manufacture of the sulphuric acid is obtained by heating nitrate of sodium and sulphuric acid. This is often done by making the heat from the smoldering pyrites warm the vessel in which the nitric acid is being made. The vapor of the acid thus produced passes through flues into the leaden chambers along with the sulphur dioxide. Nitric acid is an exceedingly powerful chemical substance and brings about most violent chemical changes. It is therefore necessary to keep it well away from substances which are liable to undergo combustion, such as wood, etc.; thus no woodwork should be allowed near the pyrites kilns or niter pots. Also, the addition of any organic matter, such as coal dust or coke, to the sodium nitrate (or "Chili saltpeter" or "Nitrate," as it is sometimes called) should be most carefully guarded against. Moreover, the store of nitrate should be in such a place where it would not be heated or liable to come into accidental contact with sulphuric acid.

Before the mixed gases pass into the chambers they are made to pass up a tower, called after its inventor a Glover tower. This is made of lead, in the upper parts, of about 22 pounds per square foot; in the lower, of perhaps 40 pounds. This lead is lined by thick firebricks capable of resisting both heat and strong acid. This lining is stouter at the bottom, where the heat is greater. The height varies somewhat according to the size of the leaden chambers, a common size being about 10 feet square and 30 feet high. The lower part is fitted with hard flint or other similar substance not attacked by hot and strong acids. On top of these flints coke is placed. This could not be used in the lower part, because it would take fire in consequence of the heat and the action of the oxygen in the nitric acid.

The object of this tower is to treat some strong vitriol containing oxides of nitrogen dissolved in it, which is obtained in another portion of the works. It is therefore sometimes called a "denitrifying" tower. The denitrification is brought about by making the nitrous vitriol mix with the ordinary chamber acid and the mixture trickle down through the coke and flint packing. By this plan a double saving is effected; for the nitrogen oxides are set free from the acid and rendered available for use in the chambers, and the chamber acid is concentrated by the heat of the hot gases.

It will be noticed that the coke packing is liable to take fire if allowed to come too near the hot briskwork and gases at the bottom of the tower; but it is also liable to fire if, from an accident, the supply of acid which is made to run over it runs short. Should this be the case, the coke rapidly dries and ignition will quickly follow. The risks of fire in a Glover tower are, therefore, of two kinds—first, due to improper construction; and, secondly, due to defective working. Both have to be carefully looked after.

After the gases have passed through the leaden chambers, instead of being allowed to go out into the atmosphere, they are made to pass up another tower, known as Gay Lussac's, in order that the valuable oxides of nitrogen which they contain may be extracted from them. This tower is something like the Glover, except that as the gases are not so hot it is less substantially built. The lead of which it is made is thinner and the fire-brick lining also, the latter being sometimes entirely dispensed with. The tower is quite filled with coke, over which sulphuric acid of about 1.75 specific gravity runs. This acid robs the gases of the oxides of nitrogen which they contain, runs out from the bottom of the tower, and is pumped up to the top of the Glover tower, as already described.

The supports of both towers, as well as of the leaden chambers, are usually wood scaffolding and, of course, should be carefully protected.

The acid made as I have described is concentrated by evaporation in open leaden pans up to a certain point and after that by distillation in glass or platinum vessels.

Strong sulphuric acid as well as most other acids is usually stored in glass carboys. If any accident should happen to one of these, and the acid come into contact with wood or other combustible substance, great heat is usually produced and charring takes place. This would not, generally speaking, produce flame, but if any substance containing a large quantity of oxygen, such as niter or chlorate, be present, violent combustion would result. Care should therefore be taken to see that the acid store is at a distance from these substances, and that, preferably, it should have stone or earthen floor.

THE BLACK ASH PROCESS.

This, the second process in the manufacture of washing soda, is carried on in large reverberatory furnaces in which a mixture of salt-cake, limestone, and small coal is strongly heated. The furnaces are very substantially built of fire-brick bound with iron, and the waste heat is generally used for evaporating the solution of the carbonate. An ordinary furnace will work off a charge of about 3 hundredweight of salt-cake in about 40 or 50 minutes; and consequently, allowing for charging and discharging, about twenty-five "balls," as they are called, of black ash will be produced in a day. When the operation in the furnace is completed, the pasty mass is raked out into iron wheelbarrows and allowed to cool. As soon as it is sufficiently cooled to be rigid the masses of brownish-black substance are stacked on stone floors for further cooling.

In place of an ordinary reverberatory furnace, the heating of the mixture of salt-cake, etc., is sometimes done in a "revolving" furnace—that is, one in which the bed is made to revolve by mechanical means, while the flame from the fireplace sweeps through the center. In this way the mass is more evenly mixed.

The black ash process is generally conducted at a distance from any combustible material, and the fire risks are not great.

THE EXTRACTION OF THE SODIUM CARBONATE.

Before the "balls" of black ash are cold, they are broken up and treated with water in large lixiviating tanks. The solution, after settling, is "carbonated" and then boiled down in iron pans heated by the waste heat of the black ash furnace. "Soda ash" is the calcined product obtained from the boiling down pans. "Soda crystals" is the material produced by dissolving soda ash in hot water, and allowing the solution to cool, when the ordinary washing soda crystals separate out.

Bicarbonate of soda is made by bringing the soda crystals into contact with carbon dioxide gas. This is done in apparatus of various shapes made of brickwork, wood, or, preferably, iron. In the ordinary mode of working there is not much heat given out by this process, and hence not much danger attaching to it.

In addition to the substance already mentioned a great many other important bodies are manufactured in alkali works. Among these are sodium hydrate, bleaching powder, and potassium chlorate.

Sodium hydrate is made by adding lime to the diluted liquid obtained by lixiviating the black ash. The tank liquid must be quite clear and boiling before the lime is added. After the settling of the carbonate of lime formed in the process, the clear fluid, which is now a solution of caustic soda, is boiled down in iron pans. Oxidation is brought about in the boiling down process by adding nitrate of soda to the liquor in the pots.

Caustic soda is usually packed into iron drums directly from the pans. It should be kept well away from any accidental contact with acid, as great heat is produced when these bodies come together, and this heat would be able to start other chemical actions which might produce combustion.

Bleaching powder is made by passing chloride into brickwork chambers on the floor of which freshly slaked lime is placed. After a little time the chlorine is absorbed and bleaching powder or chloride of lime results. If the temperature rises too high the product is spoilt, consequently the heat is well looked after and kept down. The manufacture of this substance, however, as well as that of the caustic soda, requires the use of large quantities of quicklime, which, as is well known, gives out a very large amount of heat when moistened. The quicklime store should not be kept in a wooden building, or on a wooden floor. The roof should be a good one, the sides brick, and the floor flagged or concreted. Like the caustic soda store, it is best that the lime should be at some distance from the stores of hydrochloric and sulphuric acids in order that no accidental leakage of these substances may reach it.

Potassium chlorate is perhaps the most dangerous material which the alkali-maker produces, as will be realized when we remember the recent and terribly destructive fire caused by this substance at the works of the United Alkali Company at Widnes. It is made by passing chlorine gas into boiling milk of lime, and then decomposing the calcium chlorate thus formed with either potassium chloride or carbonate. After settling, the clear liquid is evaporated, when crystals are obtained. These are dried on leaden sheets, crushed, and packed in barrels.

Potassium chlorate is not of itself combustible, but it contains such a quantity of oxygen in available condition that it forms with sulphur, carbon and many other bodies, explosive mixtures. Moreover, if it is heated it gives up oxygen, and hence supplies the very substance which bodies require to enter into violent combustion. Acids act powerfully upon it, producing great heat and gases which aid combustion. The barrels in which chlorate is packed are lined with paper; it would be advisable that lead or zinc-lined cases should be used. The chlorate store should be removed from the acids, and as free as possible from woodwork.

Within the last 30 years a new process for the manufacture of carbonate of soda has been largely adopted. This process, which is likely to revolutionize the alkali industry, is known as the "ammonia soda process," or sometimes the "Solvay process." The chemical change upon which this plan is founded is, that when carbon dioxide gas is passed into a solution of salt contained in dilute ammonium hydrate, the ammonium and the chlorine of the salt combine together and form ammonium chloride, and at the same time sodium bicarbonate is produced, which, being somewhat insoluble in solution of ammonium chloride, separates out from the mixture in the solid form. In order that the process may be commercially successful, it is necessary to recover the ammonia from the solution. This is done by heating the liquor with caustic lime.

The whole process differs from that used in the Leblanc system, and particularly in not requiring the use of strong acids. The bicarbonate is converted into the ordinary soda ash by calcining it in a furnace, but apart from this and the lime kilns comparatively few furnaces are required. Moreover, one of the conditions of success is that the chemical change referred to above shall take place at a low temperature, and hence precautions are taken that the vessels shall be kept cool by streams of cold water running over them. The fire risks are therefore not great. The only point necessary is to notice the large amount of lime used, and to take care that the storage of this substance is properly looked after.

(To be continued.)

CALCIUM CARBIDE FROM IMPURE RAW MATERIALS.

CALCIUM carbide is almost unique among commercial products in that it cannot be refined by any known method. Refining processes have been developed for all of the metals, and for the common marketable chemical products a process of purification is elaborated and adopted as a matter of course. The high melting point of calcium carbide, however, excludes processes involving recrystallization or sublimation, or any such fusion treatment as is applicable to iron, and the metals generally; and its insolubility under all circumstances prevents the application of any of the methods based upon treatment by and separation from solvents. Pure calcium carbide is now produced, therefore, only from pure raw materials, and is of necessity very costly as compared with the lower grades.

On the other hand, it is a comparatively simple matter to produce acetylene of sufficient purity for ordinary use from a low grade carbide. The calcium hydrate which remains as a residue when the carbide reacts with water is itself an efficient absorbent for

hydrogen sulphide, and other gases evolved can be readily absorbed by appropriate reagents. But the necessity for the application of any purifying means, however simple these may be, to the evolved gas, at once takes away from calcium carbide one of its chief advantages over other sources of illuminants, viz., its availability for small, and especially for portable, generators. It remains therefore as a sole practicable alternative to so conduct the furnace operation as to enhance the purity of the product, either by applying during the reduction or by incorporating with the charge, such agents as will determine the elimination of the more noxious impurities, or will render them inert during the subsequent treatment of the carbide for the production of acetylene.

This is a neglected field of study, but two suggestions to this end being noted in the literature. Hewes has proposed to use a furnace charge consisting of 26 parts of carbon, 64 of lime, 8 of calcium carbonate or limestone, and 2 of peroxide of manganese. From this charge carbides of calcium and of manganese (Mn_3C) are formed simultaneously, the latter acting as a flux to reduce the temperature of the reaction and to increase the fluidity of the product, and serving also by evolution of methane (CH_4) to somewhat dilute the acetylene and hence to lessen its tendency to deposit carbon. The calcium carbonate yields a considerable volume of gas which, bubbling through the molten carbide, is said to mechanically carry much of the sulphide and phosphide of calcium to the surface, where it forms an easily removable crust.

The second suggestion is due to Dr. Walther Rathenau, of Berlin, and forms the subject of a patent recently issued (June 18). It is proposed by him, when producing calcium carbide from either lime or coal of high silicic acid content, to incorporate with the charge a metal or compound capable of forming a silicide stable at the temperature of the reaction, in quantity sufficient to unite with all of the silicon present. If iron or iron oxide be chosen the silicide formed collects beneath the molten carbide and may be tapped from the furnace, or afterward detached from the carbide block. Compounds of copper, manganese or chromium will serve the purpose as well as iron, but the latter metal is preferred, not only on account of its cheapness, but because of the many industrial uses which are being found for its conductive and chemically resistant silicides.—Electrical World.

CENTRIFUGAL PUMPING PLANT AT WEST HAM.

WE illustrate two sets of 48-inch centrifugal pumps with vertical compound-condensing engines, constructed by Mr. John Cochrane, Barrhead, near Glasgow, says the Engineer, for the Corporation of West Ham. These pumps are intended for dealing with the storm water at the Abbey Mills Outfall, Stratford, and the quantity of water to be pumped by each engine is 266,500 cubic feet per hour against a 25-foot head. They form part of a plant of three centrifugal pumps and engines and two beam engines now being erected at Abbey Wharf under the direction of Mr. John G. Morley, A.M.I.C.E., borough engineer, for pumping the sewage and storm water of the borough, north of the docks. The total capacity of the plant is about 160,000,000 gallons per day.

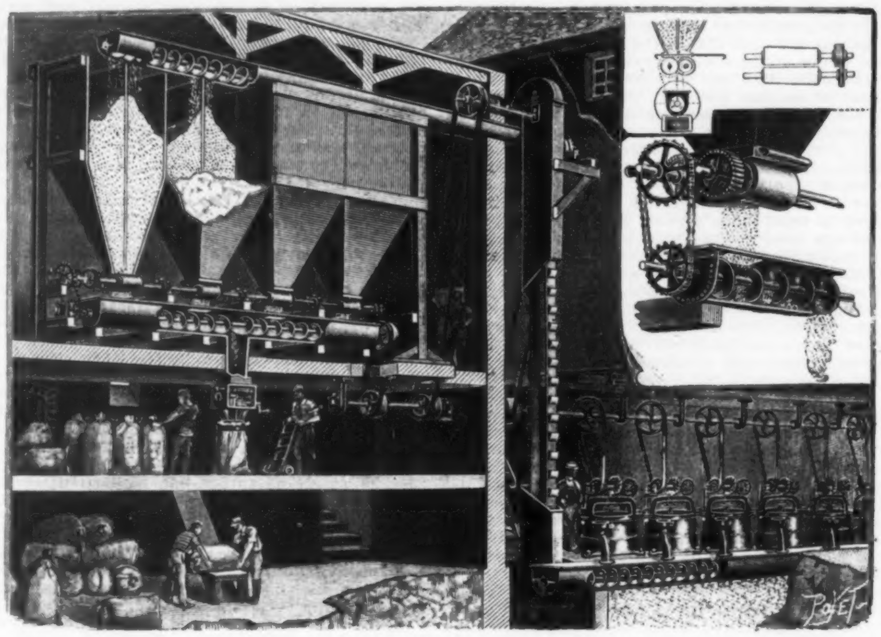
As shown in our illustration, the engines are of the compound direct-acting inverted type, the cylinders being 20 inches and 33 inches in diameter, with a stroke of 2 feet. The high-pressure cylinder is fitted with a piston valve, the traverse of which is automatically controlled by the governor by means of a swinging link mechanism of the usual type. The low-pressure cylinder has valves of the Rider type, which permit of the point of cut-off being adjusted at will. The engine is provided with a surface condenser with 1,150 square feet of cooling surface. The air pump, which is 15 inches in diameter by 9 inches stroke, is placed in a pit below the bedplate of the engine, and is driven by a beam fixed at one end to the engine framing and oscillated by an eccentric. The drive for the feed pump is obtained from the outer end of this train. The engine is intended for a boiler pressure of 100 pounds per square inch, and is designed to run at 133 revolutions per minute. The crankshaft is 7 inches in diameter and the main bearings are 11 inches long. The crankpins are also 7 inches in diameter and are 8 inches long. The impeller wheel is 84 inches in diameter and is mounted on a 7 inch shaft. It is fixed at the low-pressure end of the shaft, and outside it, again, is a flywheel 5 feet 2 inches diameter, and having a rim weighing 2.75 tons.

CENTRIFUGAL PUMPING PLANT AT ABBEY MILLS OUTFALL, STRATFORD.

AUTOMATIC SUGAR MIXERS.

IN sugar works or refineries the boiled mass, or too rich sirup removed from the boiling apparatus, is sent to the hydroextractors, in which is effected the separation of the molasses and crystals of sugar and the purification of the latter, which are collected upon a filtering cloth.

M. A. Denis, of Saint Quentin, who is specially occupied with mechanical constructions and repairs for sugar works, has been kind enough to make known to us his new apparatus designed for the conveyance and automatic mixing of sugars in crystals. These apparatus do away with the manifold and destructive handlings of these products. They lead the sugars, rendered homogeneous and freed from hardened masses, to the bagging machine, and, at the same time, regulate the quantity to be sent to the weighing machine in a continuous manner.



GENERAL VIEW OF A SUGAR WORKS PROVIDED WITH THE DENIS MIXING APPARATUS.

In the accompanying figure is represented a sugar plant provided with the apparatus just referred to. To the right, at the lower part, is a battery of 8 or 10 turbines actuated mechanically. The crystals of sugar, purified to whiteness in the centrifugal drum of these turbines, are thrown by means of a shovel into a hopper fixed against the box of each of the turbines of the battery. The hopper is enamelled in blue in order to facilitate the start of the sugar and also to permit of judging of the beauty of the crystals better. From the hoppers the sugar falls into an Archimedes screw, with enamelled spirals, which carries it to a belt elevator provided with enamelled buckets. This elevator raises the sugar to the store room. The screw in the latter is provided with valves through which the sugar is allowed to fall into one or another of 6 or 8 storage boxes placed in one or two rows under the screw. The grains of the various shades are stored in these boxes, in which may be placed the product of one or two boilings. The boxes are provided below with sliding valves that permit of opening them over a screw

situated beneath. This screw extends for the entire length of the 6 or 8 boxes composing the mixer, and is, therefore, capable of receiving the sugars falling from all the boxes. It receives isolatedly those sent from the boxes of which it is desired to effect the mixing, through the opening, for example, of the valve of the second and that of the last box. This mixing screw, which may be seen in detail in the cartouche, is provided with right and left hand spirals. It brings the grains from the extremities toward the center, in mixing the different shades and carrying them toward the delivery hopper with a view of their being bagged and weighed automatically. The turbined sugars of two, three, or more boxes may, therefore, be mixed at will. At the upper part of the cartouche are represented the details of the conical rollers for crushing the hardnesses that form in the crystals of sugar. These rollers are placed between each of the boxes and the mixing screw that leads the sugar to the hopper of the bagging and weighing machine. The object of these rollers is not only to destroy the hard masses, but also to determine the quantity of sugar that must pass per minute and to regulate the feed of the bagging and weighing machine.

The distance apart of the rollers is regulated by their lateral displacement.—For the above particulars and the engraving we are indebted to La Nature.

NAVAL WAR GAME UNDER COAST WARFARE RULES.

A GOOD deal of special apparatus, etc., to adapt it for coast warfare has been introduced into the Jane Naval War Game, and recently a big trial game was played at Portsmouth. The opposing forces were as follows:

BLUE (DEFENDERS).

One fort, mounting six 6-in. quick-firers.

One fort, mounting three old 12-in. breech-loaders on disappearing mountings.

Seven coast-service battleships: "Norge," "Eidsvold," "Heriuf Trolle," "Oden," "Thor," "Harald Haarfarge," and "Tordenskjiold," speed 15 knots. Two "Noviks," speed 24 knots.

Seven submarines, speed 12 knots; fitted with periscopes and all the latest improvements.

One dynamite gun, location unknown to attack.

One Brennan station, location unknown to attack.

No mine field permitted.

RED (ATTACK).

First-class battleships: "London" (flag), "Formidable," "Mikasa," "Vittorio Emanuele," "Benedetto Brin," "Wittelsbach."

Armored cruisers: "Asama," "Iwate."

Five destroyers, fitted with booms to attack submarines.

One observation balloon.

The accompanying illustrations will give a good idea of the battlefield. In theory the defense should have been something like impregnable; in practice it worked out that Red annihilated the defense, captured three submarines, and destroyed the coaling station with comparatively small loss.

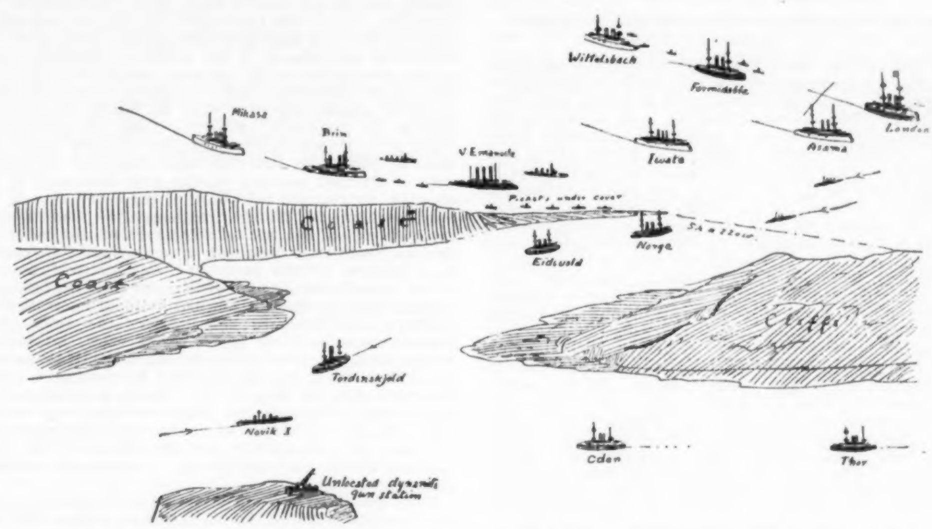
The Red side were naval officers, Blue being controlled by army officers, with a naval officer in command of the coast service squadron, etc. It will be noted that the *locale* was an ideal one for submarine boats; the rules, moreover, were very favorable to these craft, as they were assumed able to allow for tides, etc., and to steer correctly under water for any point. Nor were they exposed to any danger of being sunk by gun-fire from the big ships. It might have been expected, therefore, that they would have a "walk over."

Red began operations by lowering all picket boats and steam pinnaces, which were sent on ahead of the main division. The battle began at the Narrow Creek, where the "Norge" and "Eidsvold," lying under the shelter of a bank, fired on the "Asama." The return fire only damaged their funnels, but the attack soon availed themselves of the protection of the bank, and then, reaching an open space, poured in a fire that put the "Norge" out of action immediately. A destroyer then ran in and torpedoed both these ships without loss. The "Tordenskjiold," which was astern, promptly retired. The "Asama" and "Iwate" covered the channel while picket boats blew up the wrecked ships. "Novik I.," trying to prevent this, was torpedoed by the picket boats. These and some pinnaces penetrated the creek, and landed a Maxim on the island, where—unknown to them—the dynamite gun was mounted. These boats were captured, or retired hastily, and for a time operations ceased in that quarter.

Meanwhile the battleships, making for the main creek, came under fire of the 6-in. fort and the "Harald Haarfarge" and "Heriuf Trolle," but the ships were speedily disposed of. The fort the battleships could not hit, and some slight damage was sustained from it, but eventually they closed and destroyed it.

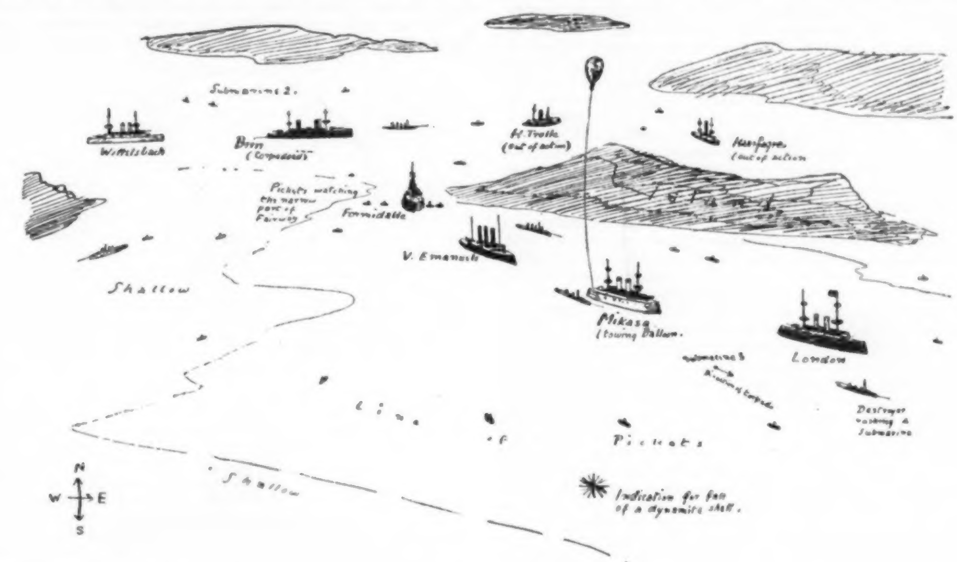
Submarines Nos. 1 and 2 both made for the point where the fair way is narrow, No. 1 having cruised thereabouts all along. It rose, however, close to a destroyer and was annihilated. No. 2 had taken a long run under water, and, having well calculated, rose unnoticed on the off-side of the Red fleet, torpedoing the "Benedetto Brin" with its bow tube. No. 3 arrived soon afterward and rose near the "London," then sank and discharged a torpedo, which was claimed in a wrong direction, so nothing happened. This boat, rising to see results, was annihilated by a destroyer. No. 2 escaped destruction and went away north, where it rose unmolested, shifted the torpedo from its stern to its bow tube, and then waited developments.

No. 4 submarine cruised about for a long time, but finally ran into a mud bank. No. 7, which lay ready in a creek near the 6-in. fort, refused to go out. By the rules of the game, when a ship is destroyed its player is out of it. The player of No. 7 was anxious not to be out of it and feared to risk the destroyers. The case was a curious one, but may well find a parallel in real war. No. 5 cruised toward the Red fleet, but finding the dynamite shell falling turned tail and lay observing upon the surface for a long while. Eventually this boat was seen by a couple of Red picket boats, which managed to come up to it quite unnoticed, and were allowed to capture it. No. 6, ordered out, hesitated to attack and lay on the surface unobserved. This boat eventually torpedoed the "Mikasa," but that was later.



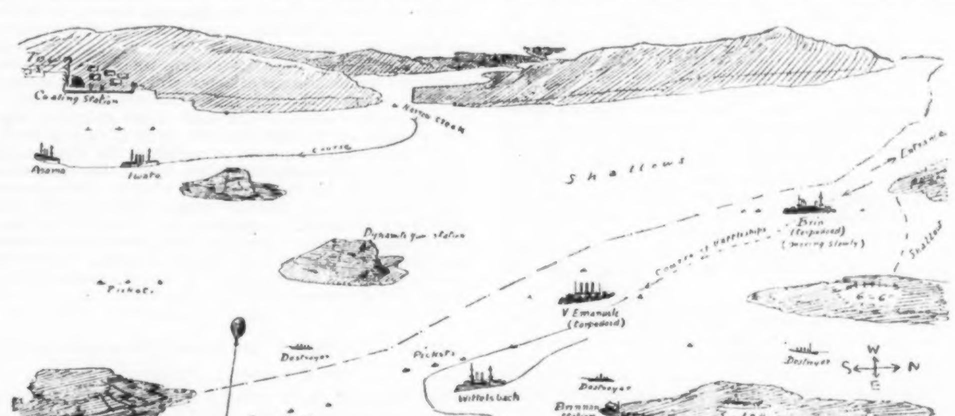
The dynamite gun fired six aerial torpedoes at a very easy target, but failed to hit anything. At the end of that time it was located and destroyed. So, too, was the 12-in. fort. Like the 6-in. one, it was practically "rushed" by the ships, which burst so many shell about it that it was not allowed to fire.

This attack, however, gave the "Brennan" a chance,



and the "Vittorio Emanuele" was torpedoed. The balloon managed to locate the station about this time, and destroyers put it out of action.

Meanwhile the "Asama" and "Iwate" at last got through this creek. They and the picket boats accounted for such coast-defense ships as were left; they also sank "Novik II." They then bombarded the town



and captured the coaling station. It was just after this that the submarine No. 6 torpedoed the "Mikasa," which passed slowly quite close to the boat.

The defense now surrendered, giving up No. 6, which had run on to the beach in an endeavor to escape a destroyer. No. 2 submarine was still at large; but as the fleet went and lay off the town with nets out and picket boats all round, it was unable to accomplish anything; and later on, being baseless and short of fuel, it surrendered. The game was of an interesting and instructive nature, not only as regards the relative failure of the submarines, but also on account of the fine handling of the Red fleet. All through this side exhibited fine resource. That a single picket boat should have sunk two of the defending battleships and captured a submarine may seem a remarkable achievement, even in imagery; there is, however, every reason to suppose that in actual war picket boats may well be the prime force in coast operations. Such, at any rate, is the opinion of many naval officers, and the amount of work done by these boats in Saturday's battle caused no surprise or unfavorable comment. It was, indeed, regarded as a mark of realism. The ease with which the forts were disabled may provoke comment. It can only be said that they were under very favorable rules, identical with those used by the United States Coast Artillery. Only one gun was actually hit, and this was pure chance. But the fire of the ships was about six times as heavy as that of the forts; shrapnel and lyddite alternated. The glacis and foreshore were hit continually, and it was umpired that what with the smoke

and dust, to say nothing of some guns being certainly buried, a return fire would have been impossible, because nothing could have been seen to aim at.—For our diagrams and the foregoing particulars we are indebted to The Engineer.

CONGRESS OF AERONAUTICS.*

By the Paris Correspondent of the Scientific American.

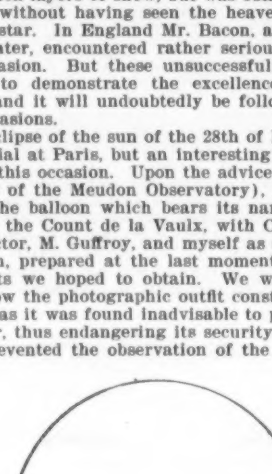
M. Emmanuel Aimé presented to the International Congress of Aeronautics, held at Paris, a description of the new dirigible balloon which he is now constructing. The Thermosphere, as it is called by the inventor, is in principle a balloon incompletely filled with hydrogen, closed below by a safety valve and ballasted so that the ascensional power of the gas is not sufficient to lift it. In the car of the balloon is a steam generator, G, to which is connected a long tube, D, passing up into the balloon and terminating at the center, O, as shown in the diagram; by means of the steam thus introduced the balloon is caused to rise and to maintain itself in equilibrium under varying atmospheric conditions. The hydrogen expands under the heat given to it by the steam and the volume of the balloon increases sufficiently to allow it to rise; by introducing more or less steam the balloon may thus be made to ascend or descend, or be maintained in equilibrium at any desired point. As the steam condenses, it forms a deposit on the inner surface of the thermosphere; it may be remarked that this liquid layer stops up the capillary openings of the varnished envelope, and assures it absolute impermeability. The water of condensation runs down the sides in streams to the lower part, where a tube brings it again to the generator, and there is no loss of water. The system thus gives a continuous circulation of the water either as liquid or steam, forming a closed cycle. In this way the heat of the petroleum burner is transported to the thermosphere and causes variations in the volume of a system whose weight (neglecting the slight consumption of fuel) is constant at all altitudes, and thus the aeronaut may control at will the supply of steam to rise, descend, or rest at any desired height without loss of gas until his provision of petroleum is exhausted; the latter may be easily renewed. The envelope of the thermosphere, which is quite elastic, has an alternating movement which is scarcely perceived by the eye, corresponding to the expansion of the gaseous mass during the ascent and its contraction during the descent; this movement is not unlike that of a fish's bladder. The great advantage of the system is that the aeronaut can choose between the superposed air currents and by this means direct to a great extent the course of the balloon. Experience has shown that a multitude of currents of varying directions exist in the same perpendicular, and it is a well-known fact that balloons, launched in a certain number at the same time and place, will always follow, however small their difference in height, different directions, these being often quite divergent and sometimes opposed. Admitting the existence of two superposed air strata which move in different directions, it is easily seen that the aeronaut, in passing from one to the other, traverses layers of air which participate more or less in the movement of each, and by changing the altitude he may place himself in the most favorable current for attaining the desired point. The wind thus plays the most important part in the direction of the balloon, and it is only necessary to provide a small propeller for the final steering. This propeller, in the case of the thermosphere, is worked by a light motor which is operated by steam taken from a branch pipe on the system above described. The steam thus serves two ends, for after leaving the motor it goes to the balloon, and gives up its energy in another form for maintaining the equilibrium, up to its complete liquefaction upon the inner walls. To sum up, the new method consists in taking advantage of air currents as much as possible for the direction of the balloon.

At the reception given to the Congress of Aeronautics by the Aero Club of Paris, Miss Klumpké, of the Paris Observatory, gave an interesting account of the progress of astronomical ballooning, and described an ascension which she herself had recently made on the occasion of the last eclipse. The first recorded observation of this kind seems to have been made by chance; on August 15, 1808, the aeronaut Garnerin, rising above the clouds, was astonished to see the meteoric shower of the Perseides; the record of his observation was, however, soon forgotten. The study of these appearances, which is comparatively recent, could have been made much sooner if the astronomers had availed themselves of this resource. Miss Klumpké continues as follows: "After isolated attempts, made in 1867 by M. de Fonvielle on the occasion of the Leonides, and in 1870 by M. Janssen during the total eclipse of the sun, aeronautical astronomy confirmed its existence in 1898, owing to the active efforts made in this direction by the Aero Club and the eminent astronomer, M. Janssen.

"It was toward the observation of the Leonides, the shooting stars of November, that the Aero Club devoted its first efforts. On the night of November 14, 1898, when a heavy fog extended over a great part of France, the Russian astronomer, M. Hansky, attaché of the Paris (Meudon) Observatory, made a balloon ascension in order to observe the marvelous spectacle which the Leonides presented at three different periods, and whose return was awaited with impatience by the scientific world. Owing to this aeronautic enterprise, it was possible to observe, in spite of the great opacity of the lower strata of the atmosphere, that the swarm of the Leonides was dispersed more than had been supposed, or else that it had been retarded for some cause. M. Hansky, during the same ascension, made a quite unexpected observation; the layers of blackish vapor which masked the heavens at Paris had less than 1,000 feet in thickness, and in consequence, if the astronomers had been installed at the summit of the Eiffel Tower, instead of at the Observatory, they would have been able to observe the shooting stars as seen from the balloon.

"In 1899, aeronautic astronomy, in the person of M. Tikhoff, carried off a veritable triumph. Like the preceding year, the clouds were an obstacle to the observation of the Leonides. While from the greater part of the terrestrial stations of the globe the observers searched in vain, M. Tikhoff, making the ascension in the balloon 'Aero Club,' directed by the Count de la Vaulx, was able to record more than a hundred of the Leonides. As it was important, from an astronomical point of view, to determine the precise moment of the maximum appearance of the Leonides, the Aero Club, on the proposition of M. Janssen, sent up a second balloon on the following night, in which I had the honor of being placed, together with M. Mallet, as captain, and M. de Fonvielle. Starting from the suburbs of Paris at 1 o'clock in the morning, we rose above the layer of fog which, this time also, enveloped the northwest of France; passing rapidly over the north of the country, we reached the shore of the ocean at 8 A. M., opposite Mont St. Michel. Although we made a careful observation, we saw only fourteen of the Leonides; this number was confirmed by a German astronomer in a balloon of the Strasburg Aeronautical Society, which was directed by Lieut. Hildebrant. On the same night a Russian and an English balloon mounted from Pulkova and Newburg; at Pulkova the astronomer, Hansky, rose to 9,000 feet altitude after having traversed thick layers of snow, but was obliged to descend to earth without having seen the heavens or a single shooting star. In England Mr. Bacon, accompanied by his daughter, encountered rather serious risks on the same occasion. But these unsuccessful attempts contributed to demonstrate the excellence of the new method, and it will undoubtedly be followed on subsequent occasions.

"The eclipse of the sun of the 28th of May, 1900, was only partial at Paris, but an interesting ascension was made on this occasion. Upon the advice of M. Janssen (Director of the Meudon Observatory), the Aero Club sent up the balloon which bears its name; it was directed by the Count de la Vaulx, with Count Castillon de St. Victor, M. Guffroy, and myself as observer. The expedition, prepared at the last moment, did not give the results we hoped to obtain. We were obliged to leave below the photographic outfit constructed for the occasion, as it was found inadvisable to pierce the wall of the car, thus endangering its security. Besides, the clouds prevented the observation of the contacts. We



THE THERMOSPHERE.

mounted in vain up to 11,000 feet altitude, but a gray fog covered the heavens; below us, the earth appeared in the midst of an ocean of uniform gray. Around the horizon rose mountains of clouds, which were brilliantly illuminated by the solar crescent, changing color during the different phases of the eclipse. In default of other instruments, we observed carefully the variations of the thermometers, and found a considerable lowering of temperature, due to the progressive eclipse of the sun, and the gradual elevation of the strata we passed through. In the space of two hours we found the enormous variation of 28 degrees Centigrade. This ascension, although its value was lessened by circumstances, is nevertheless very instructive; it shows, in the first place, that the elaboration of a programme cannot be too long or too carefully studied; it leads us to hope that the Aero Club will henceforth encourage as much as possible the observation of eclipses of the sun and moon, that science, modifying the astronomical instruments now in use in terrestrial stations, will shortly adapt them to the new conditions of an aerial observatory. Thus, on the occasion of the coming eclipses, we may hope that an international concourse of balloons on a larger scale than that of 1900 will be organized, in which astronomy will make new discoveries."

* Paper read before the International Congress of Aeronautics by M. Emmanuel Aime, Secretary of the Aero Club.

THE TREATMENT OF HEAT PROSTRATION.

By a Hospital Physician.

For the next three months we shall be called upon from time to time to discuss the general topic of sunstroke, heat stroke, heat prostration, or whatever name our friends choose to call it.

There is no doubt that too much external heat for too long a period of time will produce certain marked symptoms. In considering them we must remember the chief functions of the skin, which are to maintain the temperature of the body at a certain nearly fixed degree, and to excrete some of the body's waste products.

There are probably two centers in the brain which rule the body temperature. One regulates the production of heat and the other its distribution. They are intimately associated, and the latter is almost, if not quite, the same center which governs the caliber of the vascular capillaries. The reasons for the belief that there are certain centers in the brain that govern these functions are not pertinent here, and they are not demonstrable in the human subject on account of the impossibility of obtaining experimental evidence. Suffice it to say that they undoubtedly exist and lie at the base of the brain posteriorly—just inside the skull, in fact.

Bodily heat is produced in the same way that ordinary heat is produced anywhere else—by combustion; that is to say by the combination of oxygen with the other elements of the organic compounds of which both we and our food are made.

There are two ways in which the bodily temperature may be increased: (1) By over-production; (2) by under-elimination.

The elimination of heat is dependent on evaporation from the skin. The blood vessels bring the warm blood to the surface and the sweat glands throw out the moisture on the skin. This is to be converted into vapor and thereby to withdraw from the body the latent heat needed to convert water into vapor. This conversion of sweat into vapor, with the consequent drying of the skin, is best accomplished when the amount of moisture in the surrounding air is low. It is not so dependent on the temperature of the air, though it is most active when the temperature is high. When the percentage of moisture in the air is raised it becomes progressively less and less easy for the sweat to evaporate, and the result is that the skin becomes wet and the sweat stands in drops. Finally there is not enough evaporation to disseminate the amount produced, and the bodily temperature rises. Then the vicious circle is complete and matters go from bad to worse—the amount of surplus heat increasing continually. The amount of sweat depends on the amount of blood brought to the surface and also on the general condition of the sweat glands. The amount of blood depends on the heart and on the caliber of the blood vessels. When there is greater difficulty of evaporation there is co-ordinately less result from evaporation, and more evaporation at a low rate must take the place of less at a high rate. Consequently the surface vessels are dilated and the heart acts more vigorously and the glands secrete more fluid. These actions are regulated automatically by the centers already mentioned and under ordinary conditions of health and atmosphere the action of the skin is sufficient; when too great strain is put upon it one of two things happens; either the body temperature rises or it falls. Ordinarily it rises, for the heat-producing center keeps on acting after the second center has been proven inefficient, and the patient, if untreated, dies from simply too much heat.

In other cases the temperature falls; for so much poison is stored up that the heat center is paralyzed along with the rest. In these rather rare cases it is impossible to tell whether the body temperature was high before the patient became prostrate—for these cases are not found until they are overcome.

We must remember that the sun is not necessary to "sunstroke." Moisture is much more noxious, for if the atmosphere is dry so that the evaporation of the sweat is rapid, almost any temperature can be borne. Furthermore, there are more people overcome in buildings than in the open air. To be sure, most of the cases reported in the papers are street cases and most of the ambulance calls are for these cases, but they bear a small proportion to those not so reported. If it were the direct action of the sun, the most afflicted would be the farmers and other out-of-door laborers, whereas there are more cases among factory hands and others engaged in indoor occupations.

The reported cases are only those who more or less suddenly become unconscious. When found, the diagnosis must be made between heat, plain intoxication, apoplexy or opium poisoning. Usually this is easy, for we have first of all the extreme heat and humidity of the atmosphere. Again, the skin usually has a peculiar color that cannot easily be described but which is readily recognized. It is not simply the flushed face of alcoholism or apoplexy, but the skin is of a sort of brownish-red tinge. The respiration is apt to be rapid and shallow—not the stertor of alcoholism and apoplexy; not the slow, infrequent breathing of opium. The pupils may be dilated or unchanged; in apoplexy one is almost always dilated and does not respond to light; in alcoholism they are usually both dilated and do respond to light; in opium poisoning they are contracted. Lastly the temperature is usually elevated, it may be to 107 deg. or 110 deg. In the other conditions it would remain unchanged.

There are other points of difference, but as they are more technical, it is not necessary to mention them here. If we suspect heat stroke and yet the skin feels cool, the thermometer should be placed in the rectum to show the real interior temperature. If it registers high or subnormal, our diagnosis is made and our mode of treatment also decided for us at once.

If the temperature is high we use cold bathing to lower it, at the same time watching that it does not go too low and so give us a collapse. During the bath, which should preferably be given in a tub with the water at 80 deg. or 85 deg. to begin with, and ice at once added to bring the temperature of the water down to 60 deg. in a few minutes, the surface of the body must be rubbed vigorously, rubbing the extremities preferably toward the body and also rubbing the abdomen and back. The rubbing is to aid the heart in sending the hot blood from the interior to the skin to be cooled, and in sending the cool blood from the skin to the interior. The bath should be kept up for fifteen minutes unless the temperature drops to 100 deg. before that, or the patient shows signs of collapse. A thermometer should be kept in the mouth, or, better, in the rectum, and looked at every few minutes to be sure that the temperature does not get too low. Shivering is of no consequence—of course the water feels cold, for it is cold. Usually the pulse will become fuller, stronger and slower during the bath, and the effect will persist after it. The patient should be dried somewhat, but without much rubbing, and should lie under a sheet.

If there is no bathtub to be had, we may use various makeshifts. The best is a large rubber sheet spread under the patient with rolls of blankets surrounding him under the rubber so that he lies in an improvised rubber trough. Into this the water is to be poured as if in a tub, and when the bath is over the water may

be dipped out or siphoned out or, quicker, the rubber sheet may be folded and held so that it forms a gutter at the foot of the bed, with a tub placed under it, the head of the bed raised and the water quickly drained off.

If this is not available we may lay him on an ordinary blanket and sponge him off with cold water or rub him down with pieces of ice wrapped around with one thickness of towel. Time should not be wasted in trying to be over precise in the way the cold is applied. The thing to do is to apply cold and apply it quickly and thoroughly. By the time the second bath is due we may be in a better position to do it modishly.

It is well to give a little whisky before the bath, say an ounce and a half, or spiritus ammoniæ aromaticus one or two drachms, if the patient can swallow. If he cannot swallow we may use the hypodermic if the pulse needs stimulating.

The temperature should be taken every half hour or every hour, and as soon as it has risen again above 103 deg. or 104 deg. the bath should be repeated. If the pulse does not become better under the bathing, stimulants should be used as much as necessary—whisky, aromatic ammonia, strychnine, digitalis. As long as the temperature is high the baths must be continued. In favorable cases, however, the temperature stays down after the second or third bath.

The use of antipyretics such as antipyrin, acetanilid, etc., is not to be permitted except the patient is very carefully and competently watched on account of prostration so frequently caused by them.

The patient should drink small amounts of cold water at frequent intervals. By cold water iced water is not meant, but water cold enough to be a refreshing drink.

As soon as the fever is under control we must open the bowels freely with a brisk cathartic, the quickest acting being the best. For a few days, depending on his condition, the patient should be kept on a fluid or semi-solid diet, and he should remain in bed. As his condition improves he is, of course, to be allowed up and on fuller diet.

If instead of a high temperature we find a low one, we must at once say to the patient's friends that the case is a much more serious one than those in the class with a high fever. Such a case is profoundly poisoned and all the vital functions are at a very low ebb. The pulse is poor—weak, small and compressible, feeling as if the artery were not full and as if the heart were weak. These cases are of course not to be bathed in cold water, but are to be vigorously stimulated—whisky, an ounce or ounce and a half every half-hour or hour; strychnine, gr. 1-30 or even 1-20 by hypodermic every two hours; digitalin, gr. 1-100 by hypodermic every three hours; caffeine sodio-benzoate, gr. iij. to v. every two or three hours.

It is almost impossible to over-stimulate these cases. They should be rolled up in blankets, and hot-water bottles, hot bricks, flat-irons, etc., put around them to raise the temperature to normal. They should take hot drinks if they can swallow, and as soon as reaction has set in they should also have a brisk cathartic.

But we must not think that it is only the ones who are suddenly overcome that are suffering from the effects of heat. The heat and humidity are responsible in large measure for the summer diarrheas. When the skin is unable to do its work of excretion the other organs must help. It is on this account that cool bathing is so frequently efficacious in summer complaint in children, even without much change in feeding. It will be seen that, particularly in hot weather, the skin is a very important organ, and it behooves us to take the best of care of it. Frequent bathing should be resorted to. Any sort is better than none, though of course the tub bath is most efficacious. Soap should not necessarily be used for it may irritate the skin in some instances, but the entire body should be washed off at least once a day in hot weather and the skin rubbed briskly with a coarse towel. By this it is not meant that one must rub so hard as to undo the cooling effects of the bath, but there should be a gentle friction to give tone to the sweat glands and other parts of the skin. Another thing to be warned against is remaining too long in the bath. It makes no difference whether the water be hot or cold, if we feel depressed on leaving the bath, it is probable that we remained too long in the water. One must not hesitate to make the length of his bath such as is best for him, without regard for what more or less robust friends may say. Many people can get much good from a cold plunge of a few seconds or a few minutes who get nothing but harm from a sponge bath. Others cannot take any sort of a cold bath but can take tepid or hot baths. The danger of feeling depressed is greater after these than after cold ones, for the temptation is greater to remain in the water too long.

It is particularly important during the hot months, and particularly during dog days when the percentage of humidity is high, that the bowels be kept in the best condition possible. All that we have said on the subject of constipation and diarrhea is to be reiterated, but need not be repeated here. The drinking of alcoholics should be very carefully regulated. From what has been said about the free use of whisky in sunstroke it might be thought that drinking it would act as a good prophylactic in averting a sunstroke. That is not so, for the frequent use of alcohol tends to paralyze the skin capillaries so that they remain dilated and cannot quickly respond to the extra work thrown upon them in time of need. Alcohol is also very irritating to the kidneys, which should not be crippled when they have not only to do their own work but to help the other organs incapacitated by the heat and humidity.—Druggists' Circular.

British Exposition in St. Petersburg.—Deputy Consul-General Hanauer reports from Frankfort, June 1, 1901:

There is planned for next winter an exposition of British products at St. Petersburg. Committees of prominent men have been formed both in London and St. Petersburg to have charge of the matter. According to the German paper containing this news item the Russian Ministry of Finance has granted exhibits free entry at the custom-houses.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

Competition for Automatic Lorry in Great Britain.—The Department has received from the British embassy in Washington, under date of June 10, 1901, copy of a notice of a competition for a self-propelled lorry, or wagon, for military purposes. Three prizes are offered for the three self-propelled lorries best suited to military requirements: A first prize of £500 ($2,433.25), a second prize of £250 ($1,216.62), and a third prize of £100 ($486.65).

Firms or individuals intending to enter for this competition must send in their names to the secretary, mechanical transport committee, War Office, Horse Guards, Whitehall, London, England, on or before September 1, 1901. The conditions are summarized as follows:

CONDITIONS.

No vehicle will be admitted to the trials unless a fully dimensioned set of drawings and a specification, giving complete details of the lorry and trailer exactly as submitted for trial, together with a statement of the purchase price, have been lodged with the secretary, mechanical transport committee, before December 4, 1901. The trials, carried out by the War Office committee on mechanical transport, will commence in England on Wednesday, December 4, 1901, and will extend over a considerable period. The exact nature of the trials will be decided by the above committee, which reserve to themselves full powers to carry out any additional tests, and also the power of rejecting any vehicle which does not comply with the requirements published herewith, or of suspending, at any stage, the trials of any vehicle which in their opinion has proved itself unsuitable. A firm or individual may enter more than one lorry, but the conditions must be complied with for each separate lorry entered. All designs and specifications will be considered confidential. Those of the vehicles that may be purchased will be retained for the purposes of the government, but without prejudice to patent rights. His Majesty's government will have the right of purchasing, after the trials, any or all of the competing vehicles at the price stated by the competitor. The designs and specifications of vehicles not purchased will be returned to the competitors after the trials.

STATEMENT OF REQUIREMENTS OF SELF-PROPELLED LORRY FOR MILITARY PURPOSES.

The lorry to be capable of being used on rough roads, and to a limited extent across country. To be able to go wherever a country cart can go, and to be capable of being driven through an opening 7 feet 6 inches wide. Net load to be 5 tons, of which 3 tons must be carried on the lorry and 2 tons on a trailer; these weights are exclusive of fuel and water, all of which must be carried on the lorry. The total platform area not to be less than 15 square feet for each ton of net load; both platforms to be fitted with removable sides and ends about 2 feet high. The top of the lorry platform when ready for loading not to be more than 4 feet 3 inches from the ground level; that of the trailer not more than 4 feet. The lorry and trailer carrying their full net load of 3 and 2 tons, to be capable (1) of a speed of 8 miles per hour on fairly level roads in fair condition; (2) of a mean speed of at least 5 miles per hour on average roads, up and down hill; (3) of taking its full load without assistance on an average road, up a slope of 1 in 8. The weights should be so distributed that the lorry should always be under control on slopes up to 1 in 8, whether loaded or empty. There must be proper arrangements to avoid damage from mud or dust. Any casings used must be easily removable. The lower portions of the machinery must be strongly protected and not less than 18 inches from the ground, except the driving gear, which should be kept as high as possible. The lorry to be capable of efficient control, of steering at all speeds, of reversing at low speeds, and of being worked and controlled by one man. It must also be able to run for forty-eight hours without overhauling and cleaning. The driving-wheels not to be less than 4 feet 6 inches in diameter, nor less than 9 inches wide across the tires, which may be fitted with plain diagonal road strips. No restriction is placed on nature of fuel or class of engine—steam, internal combustion, or otherwise—except that oils under 75 degrees F. flash point (Abels' close test) must not be employed. In the case of steam engines, an alternative arrangement for burning solid or oil fuel is desirable, and the engine must comply with the requirements of the Manchester Steam Users' Association. No limit is placed on tare weight. In judging the merits of competing vehicles, the following points will be considered: (*a*) Prime cost, having due regard to efficiency; (*b*) distance that can be traveled by the vehicles fully loaded with 5 tons, carrying fuel and water on the lorry; (*c*) economy in weight; (*d*) durability; (*e*) accessibility of all parts; (*f*) simplicity of design; (*g*) ease of manipulation; (*h*) absence of noise, vibration, and smoke.

For further information, application should be made to the military attaché, British embassy, Washington.

Suggestions for Exports of Ironware and Machinery.—The following suggestions for export of ironware and machinery were taken from trade papers and reports published in the interests of German exporters, and may be of value to our manufacturers:

STOVES IN BULGARIA.

Iron stoves, as reported by the Commercial Museum of Bulgaria, are coming in use more and more, having driven out of the market the tin-plated stoves, which used to be in great favor. Germany was the first country largely controlling that market, but has lately experienced formidable competition from Belgium and England.

AGRICULTURAL MACHINES IN RUSSIA, EGYPT, ALGERIA, AND AUSTRALIA.

The St. Petersburg Commercial and Industrial Gazette calls attention to the "Zemstvo's" direct purchase of agricultural implements and machinery. This institution, a combination of agricultural interests, sends out representatives to buy machinery in large quantities, and it would be advisable to seek direct connection therewith.

As to Russia's import of tools, Germany furnishes the cheaper and medium grades, while the best qualities come from France and England. Pitchforks, spades, etc., are very rarely imported, although home industry is not able to supply the market to its full extent.

A British consular report from Alexandria says that, with the great progress made in cultivating farming land in Egypt, a greater demand for agricultural implements is to be expected.

Farmers are finding out the advantages of improved farm machinery, having in use already a number of threshing machines.

The increase in the import of agricultural implements into Algeria is due to the large number of settlers emigrating to that country, and the French are making great efforts to drive America and England out of the market in this line.

Manufacturers desirous of selling their agricultural machines to Australia are recommended to follow the example of Americans—having their machines set up and tried by a representative. English firms are beginning to adopt this method. Soils in Australia differ greatly, so that machines very useful in one region are altogether unserviceable in another.

IRONWARE IN ABYSSINIA.

Among the ironware used in Abyssinia, the British consul describes pans, diameter of 1 to 3 feet, about 4,000 being imported during the year, at a cost of 3 to 9 marks (71 cents to $2.14) each. These are mostly furnished by India and Germany. Other articles imported comprise files, nails, penknives, padlocks, screws, saws—all together to the value of about 15,000 marks ($3,570).

CUTLERY IN MOZAMBIQUE.

The British consul at Mozambique reports that Germany supplies the country with cutlery, England not being able to furnish as durable goods at the same prices. The natives care less for the appearance than for durability.—Max Bouchsein, Consul at Barmen.

American Office Furniture in the Netherlands.—The sale of American furniture in the Netherlands does not increase. The reasons alleged are: (1) Imitations of American desks are made by Dutch manufacturers and sold at a lower price than the original. American prices range from 60 to 270 florins ($24 to $108), while Dutch desks are sold as low as 35 florins ($14); (2) American manufacturers sell draft against bill of lading, while the Dutch manufacturers allow a credit of from three to six months; (3) there is no stock of American furniture here, and desks must come either from the United States or from branch houses at London, which last requires eight days; while Dutch manufacturers deliver at once.

It would be advisable for American manufacturers to have agents here with full stock, thus insuring speedy delivery on order.

This office is provided with two fine oak roll-top desks, and also with a revolving bookcase of the best design, dictionary stand, and leather furniture. I have lately had made for the consulate a newspaper rack, but had to send to Paris for the file holders. These articles are excellent advertisements and attract favorable attention, but are too expensive to sell readily.

Still, I believe that if a proper exhibit of American office furniture were made here, some business—especially in the cheaper grades—could be done.—Frank D. Hill, Consul at Amsterdam.

Rapid Mail Train in France.—Consul Haynes writes from Rouen, June 3, 1901:

The Paris-Lyons-Mediterranean Railway Company, by an agreement with the postal authorities, has established for the first time in France a rapid mail train, exclusively for the purpose of carrying letters, papers, and other objects of correspondence.

It was put on the road June 2, 1901, and will leave at Dijon, Macon, Lyons, and Tarascon, the cars intended for Switzerland, Italy, and the middle of France.

The cars containing the colonial correspondence or mail for the Orient will be stopped at Marseilles, to facilitate its transportation on board ship. The rest of the train will continue to Nice.

British Barley and New Sugar Duty.—Consul Marshal Halstead, of Birmingham, under date of May 2, 1901, notes complaints published in the London Times, to the effect that the new sugar duty will lessen the use of British malting barley. The writer points out that malt made from British barley, when used for brewing purposes, requires the admixture of either a percentage of sugar, or of a still larger percentage of malt from foreign barley, and he explains that with the new duty, the beers containing a large proportion of English barley will be taxed more highly than those containing a large proportion of foreign barley. The effect of this will be to decrease the per cent of British barley used.

INDEX TO ADVANCE SHEETS OF CONSULAR REPORTS.

No. 1076. July 1, 1901.—Suspension Railway at Loschwitz-Saxony—Pearl Fisheries in Venezuela—Persian Export of Grain Prohibited—Direct Trade of Rouen with Morocco.

No. 1077. July 2, 1901.—The Foreign Walnut Market—Growth of Shimonoseki, Japan—*Preservation of Eggs in Germany—*Preserving Fresh Fruit in Victoria—*Victorian Gold Jubilee.

No. 1078. July 3, 1901.—*Smoke-Consuming Furnaces for Germany—*Barrels in the Argentine Republic—*Costa Rican Duty on Coffee—*Communication with Iceland—*Germany's Share in the Suez Canal Traffic—*Market for Banana Meal in Europe—*Portable Houses in Caracas—Food and Drink Supply of Paris—*The Lucas Gaslight.

No. 1079. July 5, 1901.—Reduction of Copper Ores in Germany.

No. 1080. July 6, 1901.—Reduction of Copper Ores in England and Norway.

The Reports marked with an asterisk (*) will be published in the SCIENTIFIC AMERICAN SUPPLEMENT. Interested parties can obtain the other Reports by application to Bureau of Foreign Commerce, Department of State, Washington, D. C., and we suggest immediate application before the supply is exhausted.

TRADE NOTES AND RECEIPTS.

Putz Pomade.—Oxalic acid 1 kilo, caput mortuum 15 kilos (or, if white, tripoli 12 kilos), powdered pumice stone, best grade, 20 kilos, palm oil 60 kilos, petroleum or oleine 4 kilos, perfume with mirbane oil.—Drogistische Rundschau.

Mass for Printing Rollers.—Soak best Cologne glue 5000 thoroughly in water, pour off the superfluous water and melt in a kettle together with glycerin 5000. The finished rollers are rendered more resisting by coating them with a solution of potassium dichromate 50 and water 950.—Farben Zeitung.

Fumigating Candles.—1. Lime wood charcoal, 6,000, saturated with water (containing saltpeter 150 in solution), and dried again is mixed with benzoin 750, styrax 700, mastic 100, cascarilla 450, Peruvian balsam 40, Mitcham oil, lavender oil, lemon oil and bergamot oil 15 each, and neroli oil 3.

2. Charcoal 7,500, saltpeter 150, tolu balsam 500, musk 2, rose oil 1. The mixtures are crushed with thick tragacanth to a solid mass.

3. Sandal wood 48, clove 6, benzoin 6, licorice juice 4, potash saltpeter 2, cascarilla bark 1.5, cinnamon bark 1.5, musk 0.05. All these substances are powdered and mixed, whereupon the following are added: Styrax (liquid) 5, cinnamon oil 0.05, clove oil 0.05, geranium oil 0.5, lavender oil 0.2, Peruvian balsam 0.2. The solid ingredients are each powdered separately, then placed in the respective proportion in a spacious porcelain dish and intimately mixed by means of a flat spatula. The dish must be covered up with a cloth in this operation. After the mixture has been accomplished, add the essential oils and just enough solution of gum arabic so that by subsequent kneading with the pestle a moldable dough results which possesses sufficient solidity after drying. The mass is pressed into metallic molds in the shape of cones 1 to 2 centimeters in height.

4. Red Fumigating Candles.—Sandal wood 1 kilo, gum benzoin 1.5, Tolu balsam 250 grammes, sandal oil 25 grammes, cassia oil 25 grammes, clove oil 25 grammes, saltpeter 90 grammes. The powder is mixed intimately, saturated with spirit of wine, in which the oils are dissolved, and shaped into cones.—Neueste Erfindungen und Erfahrungen.

Empirical Methods of Examining Perfumed Liquids.—It is often of value to determine the composition of some cosmetic essence or another; but it is connected with great difficulty to find out the volatile oils of such preparations. It is true, some essential oils can be determined by their reaction; but for the practical man, this scientific method is often too laborious and requires much experience and practice. In the case of a mixture of various volatile oils the difficulty of determining the composition grows in proportion. The following is to indicate a method by which the oils may be detected, with sufficient accuracy as regards quality, based upon their differing volatility. It is the method of diluting with water.

If a perfumed spirit, as, for instance, a mouth water, is poured into a wineglassful of water, the oils will separate at once and spread over the surface of the water. This liquid being allowed to stand uncovered, one oil after the other will evaporate, according to the degree of its volatility, until at last the least volatile remains behind.

This process, it is true, requires sometimes weeks, and in order to be able to watch the separate phases of this evaporation correctly, it is necessary to use several glasses and to conduct the mixtures at certain intervals. The glasses must be numbered according to the day when set up, so that an accidental dislocation will not confuse.

If we assume, for example, that a mouth wash is to be examined, we may probably prepare every day for one week a mixture of about 100 grammes of water and 10 drops of the respective liquid. Hence, after a lapse of seven days we will have before us seven bouquets, of different odor, according to the volatility of the oils contained in them. From these different bouquets the qualitative composition of the liquid may be readily recognized, provided that one is familiar enough with the character of the different oils to be able to tell them by their odors.

The predominance of the peppermint oil—to stick to the above example—will soon be lost and now other oils will spring up one after the other, to disappear again after a short time, so that the seven glasses afford an entire scale of characteristic odors, until at last only the most lasting are perceptible. Thus it is possible with some practice to tell a bouquet pretty accurately in its separate odors.

In this manner interesting results are often reached, and with some perseverance even complicated mixtures can be analyzed and recognized in their distinctiveness. Naturally the difficulty in recognizing each oil is increased in the case of equivalent oils, i. e., those whose volatility is approximately the same. But even in this case, changes, though not quite so pregnant, can be determined in the bouquet, which admit of a conclusion *a posteriori* regarding their composition.

In a quantitative respect this method also furnishes a certain result as far as the comparison of perfumed liquids is concerned.

According to the quantity of the oils present the dim zone on the water is broader or narrower, and although the size of this layer may be changed by the admixture of other substances, one gains an idea regarding the quantity of the oils if the nose is also called into requisition. It is necessary, of course, to choose glasses with equally large openings and to count out the drops of the essence carefully by means of a dropper.

When it is thought that all the odors have been placed, a test is made by preparing a mixture according to the recipe resulting from the trial.

One should, however, never work with pure oils, but always prepare alcoholic dilutions in a certain ratio, in order not to disturb the task by a surplus of the different varieties, since it is easy to add more, but impossible to take away.

It is true this method requires patience, perseverance and a fine sense of smell. One smelling test should not be considered sufficient, but the glasses should be carried to the nose as often as possible.—Parfumeur.

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